THE INTELLECTUAL OBSERVER.

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MONEY AND MONEYERS.

BY JOSEPH NEWTON, OF H. M. MINT.

THERE are many conflicting accounts of the origin of money; but all agree in giving to its introduction a very ancient date. It is certain, however, that at the period of the Trojan war it was not known to the Greeks. Neither Homer nor Hesiod speaks of gold or silver. They, on the contrary, invariably express the value of things by stating that they are worth so many sheep, or oxen; and they estimate a man's wealth by the extent of his flocks and herds. The wealth of a country they judged of by the abundance of its pastures. Homer values, for example, the golden armour of Glaucus at one hundred oxen, and the brazen armour of Diomedes at nine oxen. Laertes purchased the beautiful slave, Euryclea, for one hundred oxen. In the seventh book of the *Iliad* we read, that—

> "Each in exchange proportioned treasures gave,
> Some, brass or iron, some, an ox or slave."

It is pretty certain too that no gold coins existed in Egypt till the time of the Ptolemies. Lucan attributes the invention of money to Itonus, King of Thessaly, and son of Deucalion, the hero of the mythological deluge, and who was said to have re-peopled the earth. Several other theories, all probably as baseless, have been current as to the invention of money. According to Herodotus, the first people who coined gold and silver were the Lydians. It is tolerably clear that so far as Persia is concerned, Darius, the son of Hystapses, was the first monarch who coined gold in that country. The pieces of money produced by him were named after him—"Darics"—in the same manner as the gold coins of Philip of Macedon, father of Alexander the Great, were called "Philips." The Persian coins had so little alloy in their composition, that they may almost be said to be pure gold. One of them, in Lord Pembroke's collection, weighed 129 grains, which, singularly enough, was the standard weight of an English guinea. While Persia

maintained her independence, the Darics were in extensive circulation; but after the Grecian conquest of the country it is believed that they were almost entirely melted down, re-coined, and re-issued with "the image and superscription" of Alexander.

The silver coins of Aryandes, who was appointed a prefect in Egypt by Cambyses, were of Persian mintage, and they, like the Daric, had an indent on one side, and the effigy of an archer on the other. The specimens of these silver coins in England vary in weight from seventy-nine to eighty-one grains. This discrepancy, no doubt, arose from the imperfect mode of manufacture then pursued; and, indeed, as we shall probably have occasion to show, it is next to impossible, even now, to produce coins, in large quantities, of uniform weight. With regard to the scriptural word "talent," in reference to money, it may be stated that Homer used it to signify a balance; and, in general, in his days, it was applied either to a weight or a sum of money—such sum differing in value with the country or period in which it was used. Every talent consisted of sixty minæ, and every mina of one hundred drachmæ; but of course the talent varied in weight with the minæ or drachmæ of which they were composed. When Darius became sovereign of Persia he divided the kingdom into satrapies or provinces, each of which was assessed at a fixed amount of tribute money. Those provinces that paid in silver were compelled to adopt the talent of Babylon for their standard, whilst those which paid in gold adopted the Euboic standard. The Babylonian talent, according to the showing of Herodotus, was equal to seventy Euboic minæ. The Euboic talent was so called from the island of Eubœa. It is generally supposed to be identical with the Attic talent, because Athens and Eubœa used the same standard of weight. The mina Euboica and the mina Attica consisted each of one hundred drachmæ. As represented by English money of the present day, the talent of Babylon was worth £226, and that of Eubœa, or the Attic talent, £193 15*s*.

It is well ascertained, however, that among the ancients the relative proportionate value of gold and silver was subject to considerable fluctuations. In the reign of Darius, for example, gold was thirteen times as valuable, weight for weight, as silver. In the time of Plato it was twelve times as valuable; in that of Meander, the Ionic poet, it was only ten times the value; and in the days of Julius Cæsar gold was only nine times more valuable than silver. The last named reduction was due, undoubtedly, to the enormous quantities of gold which Cæsar had "appropriated" from the temples and public buildings in the various cities he conquered.

The word "Money" is derived from *Moneta*, which, again, came from the verb *Monere*, to advise. The Anglo-Saxon

word *Monige*, the German *Muntz*, the French *Monnoie*, the Italian *Moneta*, and the Spanish *Moneda*, are palpably all traceable to the same Latin root from which comes the English word money. When Britain became subject to the Romans, no coined money was lawful unless it bore the effigies of Cæsar: it was called tribute-money. This tribute-money was not only impressed with the effigy of the emperor, but with certain inscriptions indicating rent money, represented by symbolic coins. Thus, for large cattle, the tribute-money was stamped with the figure of a horse; for less, with that of a hog; for corn-fields, with an ear of corn; and for a poll-tax, with the head of a man. The coins of the British prince Cunobeline were not only impressed with the figures of animals, but with the word *tascio*, which signified task, tax, or tribute. Without venturing further into the history of money, generally, we may at once come to its history, so far as England is concerned, and give some account of those who have been entrusted from time to time with its literal production. It is established, then, on the most conclusive bases, that in the earliest periods at which coins, or records of coining, exist in this country, mints were established in every large town. From about the close of the ninth to the middle of the sixteenth century, the practice prevailed of stamping on coins the name of the town or city at which it was minted. Thus, therefore, we possess evidence of the existence of numerous mints. In early periods, moreover, several persons as the king, certain archbishops, bishops, abbots, and others, exercised by royal prerogative, by usurpation, or by grant, the privilege of minting in the same place at the same time. Previous to the union of the seven or eight Saxon kingdoms, each of the petty kings, and several archbishops and bishops, appear to have exercised the right of coining independently, and to have put their own effigies and devices on the coin produced. After the transformation, however, of the heptarchy into one monarchy, Athelstan, who reigned A.D. 920-940, at a grand council or parliament, ordained that there should in future be but "one money" throughout the kingdom. This expression undoubtedly meant that there should be but one authority, effigy, and device—namely, those of the monarch himself—attached to, or ornamenting the coinage of the realm. At the same time that Athelstan and subsequent monarchs denied to their subjects the right of minting independently, they conceded to some of them the privilege of minting vicariously, as grantees of the crown. Accordingly, we find that royal, episcopal, and abbatical mints were in being, and in full operation long after Athelstan's "order in council."

For instance, it is on authentic record, that that monarch, the Archbishop of Canterbury, and the Abbot of St. Augus-

tine's were all engaged in coining in the City of Canterbury at the same time, and under royal ordinances. At the time, of the compilation of *Domesday Book,* and long subsequently, the king and the respective bishops of Norwich, Hereford, etc., minted at the same time in those cities, and this practice of coining, by prelates and other favourite subjects did not cease and determine until the middle of the sixteenth century. It further appears probable that in the same early times the king, archbishop, or abbot had several distinct mints in the same city at the same time. In Athelstan's *Mint Ordinance,* in the *Anglo-Saxon Records,* and in *Domesday Book* it is particularly notified, in almost every instance, how many minters, or monetarii there shall be in each place, or under each person privileged to mint. For instance, Athelstan's chief ordinance runs that at Canterbury there shall be seven minters, four for the king, two for the archbishop, and one for the abbot, and so on for other places. Now, that each minter had his own die, which, with a hammer, a pair of shears, and a balance, constituted the apparatus of a mint, is very nearly demonstrated by a variety of writs and records in which the monetarii and cuneii, or dies, agree in number. The connection between monetarius and cuneus is rendered still more obvious by noticing that, soon after the date of *Domesday Book,* the custom of specifying the number of monetarii in any place was superseded by specifying only the number of cuneii.

That the privilege of having one die did not involve the right of having another, is also tolerably certain. Those who were permitted to coin pence were not justified in coining halfpence, and *vice versâ.* Enough has been said, probably, to prove the fact that mints existed at the periods of which we speak in various towns, and that frequently there were two or three mints in the same town. In all these the monetarii were held responsible for the character of the coin produced at their particular mints, and heavy and peculiar punishments were awarded to those who ventured to abuse their trust, and debase the coinage.

Coming to a much later period, that of King Edward VI., we find in one of his letters-patent, that he and his father had "erected, as well within our Tower of London as within divers other places of our realmes of England and Ireland, sundry myntes to be employed, and ordered in such sorte and forme as is contained in certain several indentures." On the 10th of October, 1550, the same king in his journal, now extant in the British Museum, speaks of "York, Master of one of the myntes in the Tower;" and on the 21st of September, 1551, speaks not only of "York's mint," but also of "Throgmorton's mynte in the Tower." Again, in the year 1553, we find that

a commission was issued by Philip and Mary to Sir Edmond Pakham, High Treasurer of oure Myntes within oure Tower of London." During the reigns of Henry VIII. and Edward VI., while there were certainly two or three mints in the Tower there were two others without that fortress. One of these was "in the Manor of Suffolk House, in the Borough of Southwark," and another "in Duresme Place in the suburbs of London." The site of the first has since attained, and, to a certain extent, maintains an unenviable character, while that of the second is occupied by Durham Street, Strand.

Each of these distinct mints appears to have been presided over, and worked, by a single officer with workmen under him, and these were the monetarii before alluded to. From the seventh to the thirteenth century, as the coins of the intervening time abundantly testify, the practice prevailed of stamping on each coin the name of the minter, above the name, or emblem, of the place of mintage. Little, however, is actually known of the minters, or monetarii, except that in the Anglo-Saxon and Anglo-Norman laws and ordinances they were the only persons from whom penalties were exacted for debasement of the coinage. The position of these money makers in society has been much discussed, but it is pretty plain that they were servants or attendants of the king or prelate, who accompanied their master, and struck money for his use when required so to do. They were certainly in close dependance on the king, had houses or apartments rent free while at work for him, and were obliged to get their dies from the Crown Die Office.

A.D. 1132-1135 seems to have been the epoch of a systematic identification of the Mint with the Exchange, in the persons of their respective officers, the minter and the exchanger—the latter being the person appointed to exercise the prerogative monopoly of "exchanging," that is, of bullion, and coin dealing, and broking. The writ of the same date is further worthy of remark, from the fact that it implied that the whole country had been mapped out into comitatus—counties or districts—to each of which its own minter, or mint and exchange had been assigned.

This was the epoch also of the first step towards a consolidation of the exchanges and mints, namely, of the consolidation of their accounts, so far as the profits of the Royal Seignorage were concerned, by the appointment of a single accounting officer, known as the keeper or warden. It appears to have been the earliest date of the triple organization of the Mint—two other departments now being named as checks upon the master. One of them was represented by the warden, and the custos cuneorum, or keeper of the dies, and the other by the king's assayer and the "trial

of the pyx," on behalf of the king and the public. With reference to the original institution of the trial of the pyx, which ceremony is still occasionally performed, and is too well understood to need explanation here; it is only necessary to say that Ruding, a very good authority, dates it in the reign of Henry II., A.D. 1154-1189. In the year 1208, we find in a royal writ the name of operatores, or operarii monete, or workers in the Mint, introduced for the first time. From this time forward, indeed, the Mint which had previously consisted of but one operative department consisted of two, superintended respectively by the operarii, and the monetarii. Most probably the introduction of mechanical improvements in the art of coining, and possibly the increasing demand for coin, led to those changes, and gave rise to the term operarii, which might consistently be supposed to include all the labourers in the establishment.

The year 1279 is a remarkable one in the annals of British minting, for in that year the mints throughout England were consolidated in their operative departments, and placed under one mint-master. This officer, singular to say, was a Frenchman, and his name was William de Turnemire. He was sent for from Marseilles, and constituted Magister Moneto Regis in Anglia, or Royal Mint-master throughout England. It is somewhat remarkable that from this period the practice of stamping the name of the minter on the coin ceased, and it was never again resorted to. The mint agreement between the king and Turnemire refers almost exclusively to operative matters. It is preserved in the Red Book of the Exchequer, and we give some of its rather quaint and curious enactments. It appears that Turnemire was to cause the money to be made in four places "for the present," viz. London, Canterbury, Bristol, and York. In each of the three latter places he was to have under him a magister, to have the custody of the mint and money there. He was to bear all burdens and expenses in the said four places, and to provide for the wages of the monetarii, for the loss of silver by fire, sizing of the coins, as also for the wages and expenses of himself, of the deputy masters under him, and to provide his other servants with meat, drink, and dress. He was to pay for charcoal, repair of dies, and other expenses about the money. The king, however, was to provide convenient houses, to satisfy the cuneator or hereditary die-engraver, for his fees, and Turnemire was then bound to deliver the coin to the king of right standard, blanched and perfect in all respects, and he was to receive from his majesty in return, sevenpence on every pound weight of sterlings—namely, $3\frac{1}{4}d.$ for the wages of the "Monetariorum percutientium et fabricantium monetam," $1\frac{1}{4}d.$ for adjusting and sizing the

coins, and 1*d.* for wages, expenses, diet, etc. For the striking of farthings, which from their small size involved more labour in their manufacture, Turnemire was to receive 10½*d.* per pound weight. The mints under Turnemire's management were worked satisfactorily, and his system prevailed for many years. In 1281 the check upon various offices of the mints was increased, and a comptroller appointed.

Henry VII., it may be stated, was the monarch who originated our present coinage or currency. In the year 1489 he ordered the striking of a new money, of double the value of a royal noble, to be called a sovereign, and to pass current for twenty shillings. In 1504 he also first authorised the striking of shillings and half shillings, in addition to groats and half groats. By the statute of the same year he appears to have given the present form to our coins, by ordaining that every piece of his new money should have "a circle about the 'utter' part thereof; and also that all manner of gold coins thereafter to be coined, should have the whole scripture about every piece of the same gold, without lacking of any part thereof; to the intent that his subjects might have perfect knowledge by that circle and scripture when the said coins might be clipped and impaired."

He also appears to have revised the custom of placing numerals on the coins after the name of the monarch, to distinguish those struck by different monarchs of the same name—a custom which had been disused from the time of Henry III. (A.D. 1272), until his own (A.D. 1485), which now renders it extremely difficult to appropriate with accuracy the coins of the intermediate kings.

Unquestionably, however, the most important change made in connection with the Mint, between the years 1344 and 1509, consisted in the gradual rise of the joint authority of the warden, master, and comptroller, or virtual Mint Board, and in the gradual transference into their hands jointly of great part of the several supervising responsibilities of the warden, and comptroller, and of some part of the active management of the master. Into the causes and motives of these changes it is not necessary here to go. It will be sufficient for our purposes merely to record them.

The Mint indenture of the year 1350 is remarkable as being the first on record which specifies that the mint-master shall be master and worker "in the Tower." It obviously, however, contemplates his minting in several places, as the king engages to appoint wardens in each place where he shall mint. In the indenture of 1356 the wider title occurs of master and worker in the Tower of London "*et aillours parmie Engleterre;*" in that of 1395, in the Tower and at Calais, in that of 1422, in the

Tower, at York, Bristol, and Calais; in that of 1464, in the Tower, in the realm of England, in the territory of Ireland, and in the town of Calais; while in that of 1483 the mint-master becomes "master and worker in London, and elsewhere within the realm of England," and this has continued to be the usual style of the mint-master down to this hour. Other alterations in the system of government took place during the 165 years in question, but they were of minor importance, and need not be specified more exactly.

Between the years 1509 and 1544, some remarkable innovations on the purity of the coinage took place, and they are by no means creditable to the memory of Henry VIII. That monarch indeed departed from the wise mint policy of Henry VII., and debased the silver currency until it contained only one-third, or even one-fourth of precious metal, to two-thirds, or three-fourths alloy. The evils, confusion, and counterfeiting to which such a degradation of the coinage gave rise may be imagined, and indeed it took twenty-six or twenty-seven years to remedy the mischief done in this direction by Henry VIII.

An instance of the attempts made to rectify the then disordered state of the Mint may be found in the letters-patent of the year 1551 (temp. Edward VI.), reciting "Forasmuch as it it has come to our knowledge and to the knowledge of our Counsail, that there be divers and many things practysed and used within our Myntes, and by our officers and ministers in our said Myntes, necessarye for our honour and profit of our realms and dominions, to be reformed, altered, and changed." To effect these reforms the Earl of Warwick, High Admiral of England, and Sir William Herbert, Master of the Horses are by the same letters-patent nominated "Chief Commissioners, Surveyors, Controllers, and Overseers of all officers and ministers within our said Myntes, and of all rules, statutes, and ordinances heretofore had or made concerning the same." These newly appointed officers set themselves to work in earnest, and much good came of their labours. Another and similar commission was appointed in 1559, to inquire into the state of the Mint, and devise what standards, officers and ministers, ordinances, profits, etc., might advantageously be continued, or abolished, or adopted.

One material feature of change resulting from these commissions of inquiry, was the defining more accurately the constitution of the Mint. This was done in an instrument called the "Establishment of the Mint," and specifying the officers of the Mint, their duties, responsibilities, and salaries. Several of these documents were subsequently issued, with various modifications—one, for instance, in the reign of Queen Mary, and another in that of Queen Elizabeth. The "Establishment"

of the last-named monarch is the only one now known to be in existence, and it is of an elaborate, minute, and curious character; it is entitled "The Establishment of the Courte and Office of the Quenes Highnes Mynte within the Towre of London, made the 6th day of December, in the thirde yere of our Soveraigne Lady Quene Elizabeth," and did space allow we should certainly quote from it at some length. As a specimen of its phraseology and orthography, we give the following:— "Item, the Quenes Highnes is pleased that the under-treasurer, comptroller, and assay-master, for the more perfecte and sure doinge of all her Highnes affayers in the sayde Mynte, shall appointe these inferior offycers hereafter specifyed, so that they be skylfull: that is to saye, one clerke, to make the dayly indentures and other wrytyngs betwyxt the sayde under-treasorer, comptroller, assay-master, and moneyers, and he to have for his wages £10: Item, one syncker, to syncke the irons (dies), and to have for his yerlye fee £20." In this quaint fashion the whole document is couched, and it defines very closely the duties and emoluments of all employed in "ye sayde Mynte."

Before passing forward from the period included between the years 1544-71, it would be unjust to omit mentioning the following convenient Mint arrangements of Queen Mary's. Queen Mary, in reforming the currency, which she commenced doing within two months of her accession, did not restore exactly the old standard from which Henry VIII. had so disgracefully deviated, and which consisted of 11 oz. 2 dwt. of fine silver to 18 dwt. of alloy, but instituted a new standard of 11 oz. fine to 1 oz. of alloy. Had this excellent plan been allowed to continue, we should now have had in Great Britain, as in British India, a uniform alloy in both silver and gold coinages, namely, 11 parts fine to 1 of alloy. Queen Elizabeth unfortunately undid these regulations, and reverted to the old standard, and hence has arisen the difficulty of comparing the relative values of gold and silver.

So much has been said against Queen Mary, that it is a satisfaction to have something to say in her majesty's favour, and this we can conscientiously do in reference to the coinage. Queen Mary ordered that the pound weight of silver should be coined into sixty shillings, whereby every crown weighed precisely an ounce, and every subordinate coin became an aliquot part of a pound, or an ounce. Elizabeth, by debasing the silver currency to sixty-two shillings in the pound, destroyed this convenient arrangement. In restoring the old standard of gold again, Queen Mary cut the pound weight into £36, so that three sovereigns weighed an ounce. In her reign too the complete consolidation of the Royal Mints was first effected,

and the whole of her money was consequently struck in the Tower of London.

In the year 1571 many alterations as regarded the working staff were contemplated, and even proposed in the Mint, but as they did not take place it is unnecessary to define them. In respect of the apparatus, mechanical and otherwise, it may be said that up to the year 1561 it was of the most primitive nature. The hammer was the stamping-press, and shears, scales, and files the principal accessories. In the year just named the "mill and screw" system of coining was introduced by a Frenchman, who unfortunately adopted the same plan of money making for his own private behoof, and was, it is said, hanged at Tyburn in consequence. It is pretty clear that "mill and screw" did not supersede "hammer and tongs" coining for many years after the date named by Ruding for the introduction of the former. Mr. Joseph Burnley Hume—to whose indefatigable exertions while secretary of a recent Royal Mint Commission we are indebted for much historical matter contained in this paper—is of opinion that the *Company* of Moneyers was first formed between 1561 and 1578, though he cannot specify the exact date. Prior to that period they were only, he thinks, ordinary workmen; and in support of his view, *i. e.* as to the formation of the "Company," he adduces the fact that the most ancient document extant in reference to that body bears date 1578. Certain it is that from this time forward to 1851, the Company of Moneyers contracted with successive governments for the coining of the monies of the realm, and that they kept up the succession in their own body by the reception of apprentices, for whose admittance among them they received heavy premiums. Thus much in passing. We shall have hereafter to refer to the Company, and so for the present, we leave them in order to trace the annals of coining —the physical history, so to speak, of money in England.

By the year 1583 the Mint had passed into a state of considerable internal disorganization, and its expenses had materially increased. One individual—Sir Richard Martin—had obtained a kind of monopoly in the establishment. He was indeed a "pluralist," and drew the salaries for three or four offices, besides being "Goldsmith and Platesmith to the Queen." Another series of little reforms ensued, and then matters remained *in statu quo* till 1626, when a considerable departure from the constitution of the Mint took place. The power of the moneyers was much increased by the change, and they became practically mint-masters, though nominally subservient to the chief officer. No grounds appear to exist for this alteration, except the desire on the part of Charles I. to appropriate to himself profits which had previously been allowed to the

master and worker. Charles, in fact, farmed out—nominally on a sub-contract with the mint-master—the moneying process to the moneyers, thereby creating an *imperium in imperio* which paved the way for the introduction into the Mint system of many anomalies and incongruities. From the year 1626, therefore, may be traced the rise and influence of the Company of Moneyers, which influence culminated, and was overthrown in the reign of Queen Victoria.

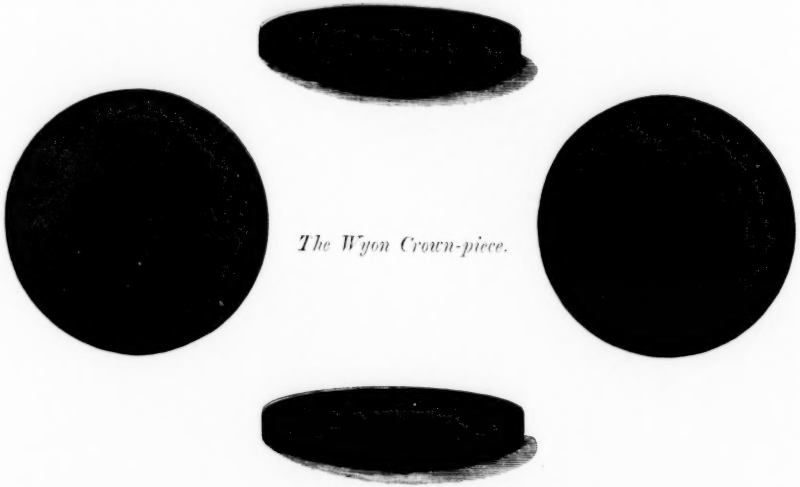
Previous to this time almost the only notices respecting them which occur in legal documents have reference to their being impressed or imported from beyond seas, or being in poverty or distress. The power thus placed in their hands by the unfortunate monarch was used in successfully obstructing, for some thirty years subsequently, the introduction of improved machinery into the mint. On the 11th of February, 1629, for example, a royal warrant was issued authorising Nicholas Briot, the eminent mint engraver, to make trial in the Tower, of his new mills and presses for coining, but up to the year 1631, as appears from a petition of Briot, this trial was never permitted. The moneyers, in fact, disapproved the experiment, and prevented its being made. Similarly, in 1649, "The Council of State and the Commons in Parliament, having had it represented to them that the coins of the realm might be more perfectly and beautifully done, it was ordained, that Peter Blondeau should be sent for from Paris to come to London to treat for the price and expense of coining money after his new invention." Blondeau arrived in London in September of that year, but though the committee of the Mint was appointed to examine his new way of coining, and reported favourably upon it, the opposition of the moneyers was so powerful that a considerable time elapsed before he could proceed to realize his plans. He was at last permitted to execute some proof pieces, whereupon the moneyers exhibited against Blondeau a charge of treason, for coining in a private house! Under pressure of this he was driven out of the kingdom. The introduction of improved machinery into the mint was thus vexatiously delayed until 1662, when Blondeau was again sent for—the office of engineer, with a salary of £100, was created for him, and profitable rates were assigned him under a twenty-one years' patent.

Before passing finally from these times, it may be well to state that it was the period when the British coinage attained its greatest beauty and perfection. In 1628, Nicholas Briot, and in 1649, Thomas Simon, his pupil, were respectively appointed engravers to the mint, in which position the latter, indeed, remained till after the Restoration; and it is a striking fact that, notwithstanding the introduction latterly of machinery of the most elaborate and ingenious kind, scarcely an approach

has been made to the excellence of the coins then executed. When it is remembered too that the inferiority of the coinage is one of the main inducements to counterfeiting this fact becomes sufficiently eloquent. As a proof of the admirable talent of Thomas Simon as an engraver, we refer to the illustration forming the frontispiece of the present number of the INTELLECTUAL OBSERVER, which is a faithful copy of his celebrated petition crown. The history of this is too well known to require repetition. As it would be an invidious act to depict only the work of an engraver of times long past, it has been considered proper to introduce also a *facsimile* of the scarcely less remarkable work of the late William Wyon—the Victoria crown piece. This arrangement may appear inconsistent with the chronological order of our narrative, but it certainly is not obnoxious to a charge of injustice towards the memory of Wyon.

Once the moneyers were compelled to submit to the introduction of Blondeau's machinery, they set about making the best bargain they could respecting it, and a new contract was arranged between them and the mint-master. They were taught and instructed in their new duties by Blondeau, and undertook to perform all the operations of minting, from the stage of the standard wrought bar downwards; to provide all materials and necessaries; to defray all waste of working, all repairs of machinery, etc. They also agreed to maintain the horses for working the horse mills, to find alum, argol, and sawdust; "to keep in repair the ovens and utensils for nealing and blanching, and to make good the balances, tubs, bowls, and sacks." Thus things went on till the year 1666, when a new Coinage Act was passed which altered completely the financial arrangements of the Mint. It also interfered materially with the constitution of the establishment, and Ruding, no mean authority, says, that the act was "most fatal to the interests of the mint."

Between the years 1695 and 1697, a great re-coinage into milled money, of all the clipped and defaced hammered silver money of the country took place; and on April 6, 1697, a committee of the House of Commons, appointed to inquire into the "Miscarriages of the officers of the Mint," made its report. This report is of a most interesting character, and throws great light upon the internal economy of the money manufactory as it existed at that time. It is, unfortunately, of too great length for transcription here. We may, however, mention that Dr. (afterwards Sir) Isaac Newton, who was then warden of the mint, figures in the report as a witness examined by the committee. A number of stringent resolutions were passed by the committee, who also proposed to bring in a bill for the prevention of



The Wyon Crown-piece.

EDGE INSCRIPTION.

ANNO • REGNI • UNDECIMO • DECUS • ET • TUTAMEN.

sundry malpractices which they had discovered to exist in the Mint. It does not appear, however, that any bill was brought in, or that any material alteration or improvement followed the presentation of the report.

In 1706 the following change took place in reference to the Corporation of Moneyers, as they loved to style themselves. They were allotted certain small salaries when the coinage in one year did not reach a certain amount. Hitherto, they had not been considered to be in the position of "standing officers" of the Mint, but more in that of workmen receiving piece wages when at work. The history of this alteration, which remained in force up to the period of the dissolution of the Company, may be briefly given:—The "Corporation," in 1693, had petitioned the Treasury to the effect, "that by reason of the work falling off so much of late years, they had become poor and so much in debt, that they must be ruined without some consideration were had for them." Again, in the reign of Queen Anne a similar claim was presented; and at length a Treasury order awarded the moneyers £25 each per annum when the coinage in any one year should not reach the value of £500,000. Afterwards, in 1743, this allowance was increased to £40 per annum, under like conditions.

Probably the most important change made during the eighteenth century in the practical management of the Mint, was the total cessation of the mint-master's practical functions, and his gradual transition from a permanent practical head-officer, having personal knowledge of the process of minting, to a salaried officer of rank, having frequently no knowledge whatever of the process of minting, and quitting his office with every change of ministry. This absurd and mischievous system remained in force till 1848, when the Russell ministry abolished it by the appointment, for life, of Sir John Herschel. The recoinage of the gold currency of the kingdom, in 1774, effected a considerable improvement in the status of the Company of Moneyers. The number of persons comprising it had been reduced at the instance of the Government, when awarding them subsistence-money; and the consequence of the recoinage of gold was, that large profits were shared by comparatively few persons. They were thus raised to affluence, and the tone of their communications varied accordingly. In 1780 an attempt was made to abolish the Mint altogether, and to place the coinage in the hands of the directors of the Bank. This, in fact, was the avowed intention of Mr. Burke's famous bill for economical reform. It set forth "that the Mint is expensive, and that the coinage ought to be none or little expense to the nation; therefore, it is enacted, that the office of the Mint shall be abolished." There were clauses for paying salaries to the

present officers of the Mint who should be removed; it was proposed too that the Treasury should contract with the Bank for coinage, and that the Bank should undertake the remittance of all money for foreign parts. It is needless to say that this bill never became part of the law of the land; and that the Mint, with all its faults and shortcomings, remained unscathed by Mr. Burke's onslaught.

In 1806, and some years after the pressure upon the Royal Mint had necessitated the employment of contractors to supplement its exertions by the production of large quantities of copper coin, the erection of the present noble institution on Tower Hill for the manufacture of coin was commenced. It was fitted with powerful machinery, made principally by Messrs. Rennie, and Messrs. Boulton and Watt; and in 1810 the first coinage—one of copper—took place thereat. The years 1815, 1816, and 1817, witnessed considerable changes in the Mint organization and constitution. One of the principal of these was that the master or his deputy, the king's assayer, the comptroller, the king's clerk, and the superintendent of machinery—a new officer appointed to have charge of the steam-engines and machinery recently erected—were constituted a Mint Board, for the management of the affairs of the Mint. Another was, that the moneyer's rates, which had previously been fixed and mentioned in and by the indenture, were left to form the subject of a separate agreement, terminable at three months' notice, between the mint-master and the moneyers. In 1815 a statute was passed to provide for the new silver coinage then undertaken, and this contained many important enactments, which space unfortunately forbids further reference to. In 1817 the ancient office of warden was abolished, and the duties, powers, and authorities pertaining to it were transferred to the master and worker. In 1837 a Select Committee of the House of Commons was appointed to inquire into the establishment of the Mint, and much important information was elicited by it. The death of King William IV., and the subsequent dissolution of Parliament, prevented any action being taken upon the report of that committee; and until the year 1848 the *imperium in imperio* of the Corporation of Moneyers remained unquestioned, or at least, undisturbed. The end of their long reign, however, was approaching. In the last-named year a Royal Commission was appointed for the purpose of "inquiring into and reporting upon the constitution, management, and expense of our Royal Mint." This commission was composed of Richard Lalor Sheil, master and worker of the Mint, William Cotton, Esq., Sir Edward Pine Coffin, and Colonel William Nairn Forbes; and Mr. Joseph Burnley Hume was appointed their secretary.

On Tuesday, March 28th, 1848, the Royal Mint Commission first met for the "despatch of business," and their sittings continued at intervals up to January, 1849. Almost every principal officer of the establishment was examined, together with several belonging to the Bank of England, and others connected with Goldsmiths' Hall. From these examinations a mass of information was derived, and the indefatigable secretary to the Commissioners engaged himself in adding to this by his researches in the British Museum, the State Paper Office, and other quarters where information could be obtained. The Provost of the Corporation of Moneyers was the champion of that body, and he as diligently sought out evidence in support of their claims. Some of the documents handed in by this gentleman were of a curious character, and but that this paper has already extended itself to so great a length, we should feel disposed to quote from them. All the ingenuity and exertions of the Company proved of little avail, however. They could after all only demonstrate that they had enjoyed the privileges and emoluments arising from their position by "prescriptive," and not legal right. It was shown, on the other hand, that inconvenience and expense arose from the system of "farming" out, as it were, the fabrication of the coinage of the realm, and that really the Crown possessed the power of terminating the contract with the Company at a very short notice.

Accordingly the Commission in 1849 reported to Her Majesty the results of their inquiries and deliberations. Without troubling the readers of the INTELLECTUAL OBSERVER with the whole of the reasons which induced the Commission to come to a conclusion completely adverse to the Company of Moneyers, and fatal to their further existence as a corporate and privileged body, it may be well to extract from their report one of its main clauses:—"We are convinced," say they, "that the Moneyers' claim of exclusive right rests on no more substantial ground than ancient usage, no charter or other written record of its commission having been produced by them, or otherwise discovered to exist; that it cannot be shown that they existed as a distinct united body earlier than the middle of the sixteenth century; that their pretensions to be a separate corporation, with legal rights, are supported neither by proof nor probability; and that if the abolition of their long-exercised privilege of exclusive employment in the work of the coinage should ever give them a title to pecuniary compensation for the loss of its advantages, they have in no way established their right to its perpetual continuance."

It was impossible to misunderstand language so plainly expressed as this, and it is certain that so acute a lawyer as Mr. Sheil would not have appended his signature thereto unless

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fully justified by the facts and evidence adduced. Many months elapsed, nevertheless, before steps were taken to remove the Company from their posts. There were, during the years 1849 and 1850, great demands made upon the Mint for gold and silver coin, and it was probably considered unwise to dislocate existing arrangements during the existence of the pressure. The Moneyers were not averse to the delay for their percentages upon coin produced were going on, and these were of more value than the retiring allowances which they were likely to obtain when superseded.

Meanwhile Captain (now Colonel) Harness, of the Royal Engineers, was appointed Deputy-master of the Mint, and he at once, and with consummate talent and vigour, applied himself to the task of framing a new system of government for the executive department of the establishment. The work was arduous and difficult. The moneyers had retained in their own hands the exclusive control of the operations of the coinage, and they were not too willing to transfer to others the results of their experience. The new deputy-master was not to be deterred by the reticence of those over whose heads the "sword of Damocles" was suspended, but he carefully and cautiously completed his plans, and prepared himself for his future campaign. Mr. Sheil was succeeded in the Mastership of the Mint by Sir John Herschel, towards the end of the year 1850, and at the beginning of 1851 the moneyers received the "notice to quit" which they had so long been expecting. Again fortune favoured them, the Bank pressed the Mint for gold coin, and they were asked to retain office some time longer. This they did until the autumn of that year, when their connection with the place was finally and irrevocably severed. By way of compensation they however received annuities, varying in amount from £500 to £1000. At the time of their official dissolution the number of moneyers was five. There were also two apprentices to the company, and these received annuities amounting to £150 each, for their loss of prospects.

Thus terminated the reign of the moneyers, whose history has been elucidated as far as the space allotable here for the purpose has permitted, and thus passed away an institution which, in one form or another, had existed from the time of the Heptarchy. It only remains to be said that in the hands of the Government the Royal Mint has lost none of its efficiency, whilst the country has gained considerably, in a pecuniary sense, by the change. Sir John Herschel retired from his office in 1854, and he was succeeded, in April 1855, by Professor Graham, F.R.S., who at this moment is Master of the Mint.

It would be unfair to omit stating that *Duncan's Work on the Currency* has been laid under contribution for some

facts in reference to the early history of money. With this acknowledgment the subject of "Money and Moneyers" may be for the present left, although the writer is conscious that much of interest in reference to it remains unsaid.

MACHINERY AT THE EXHIBITION.

BY J. W. M'GAULEY.

PROCEEDING from the western dome northward, along the transept, we catch such a glimpse of the vast collection of machinery to be found in the western annex, and of the immense building itself, that we must assuredly be devoid of all curiosity, and must feel very little interest in arts and manufactures, if we do not experience the most intense desire to explore its wonders. And that such are the feelings of the great majority of those who visit the Exhibition, is evinced by the fact that the machinery department is at all times one of its most crowded portions. The great advantage of such assemblages consists not only in the opportunity which it affords to every one of becoming acquainted with the various machines which are used for industrial purposes, but also in the means it supplies of making comparisons, and thus marking with accuracy the progress of improvement. At the last Exhibition the specimens of what might be done in the different branches of mechanical art were calculated to awaken the deepest interest; but South Kensington presents to our view at this moment such a collection of machinery as was never before seen in one place; and possibly during the existence of the present generation shall never be seen again. Its superiority over everything of the kind is manifested not only by the number of specimens exhibited, but by the great size of some of them. In this one vast hall are collected almost every contrivance of practical utility, and the mechanical requisites of almost every art and manufacture.

Machinery had made great progress at the time of the last International Exhibition; the skill and ingenuity of modern times had even then devised all the admirable contrivances, by means of which we are at present enabled to perform such wonders in the constructive art, and to work on so large a scale, and yet with such precision. And if we examine the different modes that are used for obtaining motive power, or of applying it to practical purposes, we shall find that we have not, since 1851, either increased their number or, to any considerable extent, augmented their capabilities. There is no

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species of steam engine now in use that was not at that time well known and skilfully constructed; but the extent to which the various kinds are used has undergone some modification, since the oscillating-engine is less and the trunk-engine more commonly employed. Certain important alterations also have been made in the form and in the arrangement of marine-engines. These are due to the screw-propeller having in a great measure superseded the paddle-wheel. At the period of the last Exhibition, almost every steam vessel was furnished with paddles; but experiments had recently been made, which rendered it probable that the screw would be applied to vessels of war, although no idea was then entertained that it possessed advantages which have caused it since to be almost universally adopted in the navy. The change which has thus taken place has rendered a considerable modification of the marine-engine necessary; it must have a higher velocity, and the crank-axle must occupy a very different position from that which was formerly assigned to it. There is also a great and general endeavour to diminish the space occupied in steam-vessels by the engines; hence a great compactness has been given to them, and a great condensation of their parts has been effected, and this has been accompanied by an augmentation of their strength and solidity. This is effected in various ways; the beam, in every form, has been nearly discarded, and direct-action engines are almost always used in steamers. When the oscillating engine is employed, there is no connecting-rod; when the trunk-engine, there is no piston rod; and the use of a double piston-rod, causes the piston and connecting-rods to occupy only the space usually required by one of them. Moreover, the position and form given to the condenser and pumps, tends more or less to the economization of space. When the screw was first applied, the required velocity was obtained by gearing, or some similar contrivance; but these methods have been abandoned, and the screw-shaft is driven to its full speed by the engines themselves. In 1851, the largest steam-engines exhibited were of but six hundred horse power; those in the present Exhibition include engines of eight hundred horse-power, and portions of others of twelve hundred and fifty, and even of thirteen hundred and fifty. Nothing can exceed these admirable specimens, in the arrangement of their details, and the excellence of their finish. Stationary engines also have been modified to some extent, chiefly by a more general use, and a more simple application of the condenser and of the principle of expansion. The latter was well understood long since, but it is now being generally applied in the best manner, and in most cases with a power of varying its extent at pleasure.

Powerful locomotives were found in the last, and they are very numerous in the present Exhibition; but they have undergone very little change in the arrangement of their details; the chief innovation, perhaps, being the use of injectors instead of feed-pumps. On the present occasion the magnificent line of locomotives found in the western annex presents a most imposing appearance. In connection with this subject, we ought to notice the method adopted by the London and North-Western Railway Company, for supplying the tenders of quick trains with water without stoppage; it is very simple, and is fully illustrated by the model exhibited; there seems to be no reason why it should not be very generally adopted. An excellent opportunity is afforded, on the present occasion, of comparing the various kinds of engines as constructed by ourselves and by foreigners: and in making such a comparison we cannot fail to be struck by certain novelties in two Austrian locomotives. One of them, which has *four* cylinders, is intended for high velocities; it is supposed to secure greater safety, and a more perfect freedom from the jumping which arises from the necessarily imperfect balancing of parts, by a more equal distribution of force on the crank-axle. Whatever may be found to be the result of such an arrangement in practice, the weight, complication, and expense of construction and repair are seriously increased. The other locomotive, which has *ten* coupled wheels, is intended for steep inclines and sharp curves; its weight is distributed more uniformly, on account of the number of wheels, and adhesion to the rails is rendered more effective by all of them being coupled. To prevent strains, a certain amount of motion is allowed to the axles at the boxes, and the coupling, from its form, accommodates itself to the curvature of the line, being lengthened at the outer and contracted at the inner side. Whether this capability of self-adjustment is compatible with firmness and strength, is a matter which may fairly be questioned.

Machine-tools rank next in importance to the steam-engine. All those we employ at present were in general use in 1851, though some of them have undergone modifications and improvement; and it may be affirmed that, during the past eleven years, we have neither increased their number nor much extended their usefulness; nevertheless, practical mechanics and the constructive art have progressed during that period. We cannot, it is true, point out any novelties in the strict sense of the word. Our chance of producing these becomes every day diminished; the constant exertions of men of the highest genius and most extensive experience must have brought forth so much fruit, that comparatively little in the

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way of machinery must remain to be discovered. But there is, and there always will be, abundant opportunities for making valuable improvements in practical science, and the time that has elapsed since 1851 has been by no means barren in such indications of progress. This will be sufficiently evident to those who compare the past with the present Exhibition. Eleven years constitute a very considerable portion of the duration of human life; those who eleven years ago were young are now of mature age; and those who were then of mature age are now old; but we and numbers of our readers can make the comparison. In doing this, it is impossible not to advert to the very important part which is played by those contrivances which are included under the general name of *machine-tools*. In reality they are the means by which all improvements are effected in the construction of the various kinds of machinery; and thus, indirectly, they are the sources of every advance in arts and manufactures. The imperfections of these appliances, or, as we ought rather say, the want of them, caused the greatest difficulties and embarrassments to Watt in his endeavours to improve the steam-engine. But time removed these obstacles to the carrying out of his admirable conceptions. This, however, was merely in accordance with a general law, by force of which the creation of a demand is always followed by a means of supply. Thus the necessity of forging an unusually large bar led Nasmyth to the invention of his steam-hammer. The impossibility of guiding a turning-tool with accuracy, or indeed at all, without almost intolerable labour, in the case of very heavy work, led to the invention of the slide-rest. The nearly incontrollable vibration of a long bar, in a single lathe, led Whitworth to the invention of his duplex: and such instances might be multiplied almost without limit.

Comparing the machine-tools exhibited in 1851 and 1862, we find that the lathe, planing, slotting, and drilling-machines, exhibited on the last, might very well take their places on the present occasion, so little have they been altered. The lathe is by far the oldest contrivance, and it is still the most generally used in the construction of machinery. In its best form, it may be considered as a kind of universal appliance, that to a great extent may be made to supply the place of every other; for besides turning, it will bore, and drill, and even plane, etc. As might be expected from its importance, it was not only well represented at the last Exhibition, but on a very large scale also; since, among the specimens of it were some for turning railway-wheels seven feet in diameter, and shafting thirty-six feet in length, and we have scarcely advanced farther since that time. The enormous weight of those lathes which are used for

boring large cylinders, both then and now, prevented their being exhibited.

The planing-machine, though in some respects improved, has undergone no very serious modification since 1851. The ponderous nature of the larger machines, must always present great obstacles to their being transported from place to place, and must render the proprietors unwilling to move them without very urgent necessity. The difficulty experienced in such circumstances has however been greatly lessened, by the use of the steam-crane; masses of eighteen or twenty tons weight, and even more, are now handled without any difficulty: and hence the larger machines are better represented on the present than on any former occasion. Shaping, drilling, and other machines of an equally important character, are found in great numbers in the present exhibition, as was true also of the last.

There are certain contrivances of great importance to the machine-maker, which have advanced more perceptibly. Thus the steam-hammer, which, in 1851, was comparatively a clumsy and complicated machine, has become compact and simple, while its efficiency has been greatly augmented. In its most imperfect form, it was still a welcome substitute for the old forge-hammer. The latter weighed at most a few hundred weight, the steam-hammer often weighs fifteen or twenty, and sometimes fifty tons, and yet can be controlled with the utmost exactness. It has greatly the advantage of the radial hammer, on account of its whole weight being effective, and its face being in all circumstances parallel to the face of the anvil. It enables us to manufacture immense masses of iron and steel with great ease; and to weld them, if necessary, with but little danger of leaving flaws: its capabilities are well illustrated by the very large crank shafts, both in the rough and finished states, which are seen in the eastern and western annexes. In 1851 it was not exhibited in action; at present many specimens of it are in operation daily.

The steam-crane, to which we have already alluded, is another contrivance that greatly facilitates the construction of machinery. It was barely invented at the time of the last Exhibition, and the steam was supplied to it by a separate stationary boiler; at present the boiler is attached to it and without its bulk being inconveniently increased. Steam-cranes did good service during the erection of the exhibition buildings; two of them raised all the ironwork to its position, and a few more brought the heavy goods and machinery to their allotted places. One of those used on such occasions is exhibited.

While we direct attention to the present favourable state

of constructive science, we must not pass over unnoticed those proofs, afforded by the present Exhibition, that for some the teachings of experience are of little avail, and that time, ingenuity, and money are often wasted on contrivances which have been sufficiently tried before and found wanting. The principle of expansion is now universally received as of unquestionable utility, but the way in which it is carried out is not always in accordance with the progress which has been made: and hence we find engines exhibited, in which it is applied by the methods of Hornblower and Woolff, that have been long since exploded. It has been clearly established that no practical advantage is gained by expanding the steam in a separate cylinder. A heavy flywheel is almost always found to produce sufficient uniformity of action, but if the variation of power consequent on carrying the expansions to great lengths is found inconvenient in particular cases, it is a more advantageous and almost as simple a mode of remedying the inconvenience to use the two cylinders in the form of a double engine, whose piston rods, as in the case of marine engines and locomotives, act on the crank axle at right angles to each other.

The caloric engine also is exhibited, although many experiments have shown that it is surrounded with difficulties which in practice cannot be overcome. This would have been an excellent opportunity for repeating the experiments which have been recently made at Paris, and, as it has been triumphantly asserted, with so much reason for hope.

We find electro-magnetic engines also. In 1851 numbers of these were exhibited; and the jury, as they inform us, entertained very sanguine expectations of their ultimate success. Time, however, has shown these expectations to have been without foundation, and they are now indulged in by very few. The electro-magnetic engine, as we have shown, page 22 (I am referring to the first number of the Intellectual Observer), cannot possibly compete with the steam-engine in economy, were there no other obstacle to its adoption. Electro-magnetism has been recently applied to a purpose the success of which is far more probable—the production of artificial light. The principle on which this is sought to be effected is illustrated, at the Exhibition, by two machines of considerable power; the one English, with commutators, the other French, without them. It is certainly capable of emitting a very intense light: and, after the machine is constructed, at the cost of little more than a small amount of steam power; nevertheless, though its advocates are very confident of success, there does not seem at present much probability of its general application as an illuminating agent, even in lighthouses, for which it is supposed to be specially adapted.

There are many points in which the present Exhibition reminds us of the progress which has been made. Castings are now produced with ease that but a short time since would not have been even attempted; cylinders are now bored and finished which a few years ago would have been considered of unmanageable size; forgings are executed which not long ago would have been out of the question. To prove the accuracy of these assertions, we have only to direct the attention of our readers to the connecting-rod and crosshead exhibited by Maudslay and Field, and to the cylinder and crank-axle exhibited by Penn and Sons.

Another improvement which has been introduced, is the use of steel more generally, and in very much larger quantities. Its advantages have always been admitted; it is far more to be depended on than iron, and, with the same strength, may be much lighter and less bulky; but, until recently, its cost and the difficulty of obtaining it in large masses prohibited its more general application. These obstacles have, however, been removed. The production of steel from pig-iron was proposed by Bessemer in 1856; but the process he used was for some time not very successful, an impure steel being the result. It was, however, subsequently ascertained that, when pure ores, which are very abundant, are employed, the quality of the product is everything that can be desired. The vast quantity manufactured by Bessemer's method in this and other countries is a proof of its excellence. Everything is at present made of steel; tires, rails, axles, bells, cannon, steam boilers, etc.; and it is now produced in enormous masses:—one block of steel in the western annex weighs twenty tons, and there are several others of very great size. Bessemer's process is founded on common sense; he takes just as much carbon from the pig-iron, as will leave any required quality of steel or malleable iron. In the roundabout way that was previously used, all the carbon was removed to form malleable iron, and then some was restored to change the malleable iron into steel. The rational method is now used everywhere, and the quantity of steel exhibited by the various countries is very great.

This is not the only illustration which the present Exhibition affords, of the application of scientific principles to practical purposes. Philosophy had taught us long ago that evaporation causes cold, and established the truth of this by some experiments on a small scale. But our knowledge on this point is now practically applied: and ice is made abundantly at the Exhibition by steam, the required cold being produced by successive evaporations of ether.

But to whatever side we turn, while we survey the wonders which are amassed in this great storehouse of the productions

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of human skill and human knowledge, we shall observe the utilization of scientific discoveries, and their applications to practical purposes. There is often a very wide space between the discovery of a principle in the laboratory and its application in the workshop or the factory; but the mission of philosophy is fulfilled only when the discoveries it has made have been turned to the benefit of mankind. One of the greatest advantages of such exhibitions as the present is, that all the marvels of art and science, all the fruits of ingenuity and perseverance being gathered together under one mighty roof, everyone may learn what science has achieved, and what principles have been applied to practical purposes. Of the millions who wander through this maze of wonders, many, no doubt, are occupied in considering what may be done in addition to what has been already done, what new material may be utilized, what old process may be improved or what new one suggested, what novel application may be made of the countless principles that are suggested in this vast assemblage of all that man has discovered and all that he has achieved.

HAIL AND SNOW.

BY ALEXANDER S. HERSCHEL, B.A.

All who have examined attentively the feathery down that forms the crystals of a snow-flake, and the compacter pellets of ice that characterize a hail-storm, will have asked themselves the question, What is the origin of so curious a difference in their structure? The answer is by no means long, and may be considered at this time to be pretty firmly established.

The most careful balloon ascents of the last and present centuries have shown that for every mile that ascent is made above the earth, the thermometer sinks 15 Fahrenheit degrees. It is a practice pretty commonly known, to estimate roughly by pulses of the wrist the distance of lightning flashes from the spectator, six pulses being reckoned to the mile until the first peal of the thunder is perceived; and many persons will have noticed as a fact that while near flashes of lightning are followed shortly by drenching rains, falls of hail are more commonly ushered in by distant flashes, which they follow at greater intervals of time. A flash of lightning is generally understood to announce the formation of more or less large drops of rain. The sudden refrigeration of a large highly aqueous tract of the atmosphere, converts the vapour which it embodies to mist, the small particles of which, descending and overtaking each other,

presently collect to large drops. It is the property of electricity to reside only upon the exposed surfaces of excited bodies, and hence the electricity, originally imparted to the vapour by evaporation from the earth and sea, acquires rapidly a high state of tension in exact ratio to the diameters of the drops. The latter relieve themselves of their charge by flashes of electricity to the neighbouring bodies of mist, or vapour less advanced in concentration, and lightning and thunder are the results. The drops so formed continue a rapid descent to the earth.

If we take four miles as a usual height for such flashes as precede a storm of hail, we have a cold of 60 degrees below the temperature upon the earth, or 30 degrees below freezing in our ordinary summer temperature, for the condition of the atmosphere where the drops are formed. That they are not frozen upon the spot is partly due to the warmth of the gaseous vehicle that accompanies the vapour to this height, but more especially to the latent heat evolved in the condensation, which maintains the whole at the dew-point of the existing vapour until its last portions are condensed to the fluid form. With our knowledge of the low intervening temperature, we need not however, be surprised that the drops so formed in a moderate temperature should be converted into pellets of ice before their arrival at the earth.

Why should we not then experience the very same processes in winter that are so frequent in summer?

The mean temperature of the former season approximates to the freezing-point of the scale and is more than 30 degrees Fahrenheit below our summer mean. In consequence, the snow line of the atmosphere has descended as it were two miles upon our heads, and the source and fountain-head of our hail-storms is extinguished. These are the very two miles of substratum which in summer despatch vapour of high pressure and dew-point in copious quantities to the colder regions above, and whose most violent upheavals produce the phenomenon of hail.

In winter such an elevated dew-point and pressure are rarely attained, and never in any considerable quantities. The snow that we may watch gradually wasting away upon the ground, in frosts that are long and unbroken, even when severe, bespeaks clearly the low dew-point and pressure of the aqueous vapour at this season of the year. Let us consider what occurs to such a body of vapour elevated suddenly to an unusual height above the earth.

An experiment is easily performed, which is highly instructive in this inquiry. Conceive ordinary alum to be boiled to saturation in a consistent cream of pipeclay and water, and to be set aside to cool. The deposition in crystals is found

to have been curiously obstructed. The current which in a clear solution sets constantly upwards from a forming crystal, like the rejected stream from the cilia of a rotifer, bringing to the crystal a steady supply of fresh particles for its aggrandizement, finds here an impediment to motion in the crowded grains of foreign matter; and tree-like, branching skeletons of octahedra are the result of the crystallization, as if feelers had been thrown out from a stem in quest of the saturated solution. The obstructing action of the nitrogen and oxygen gases to the crystallization of snow is of an exactly similar nature.

In the case we have supposed, where vapour of extreme tenuity is elevated, often by its own buoyancy, into regions far colder than its dew-point, a process of direct sublimation takes place. The crystallizing gas in this process bears no larger proportion than two or three parts in a thousand to the obtrusive and far denser gases among which its snow crystals must take their form. In the guarded operations of our laboratories the sublimation of pure vapours is attended with the formation of crystals of considerable solidity and often of great regularity, but in the free play of the elements the hexagonal growth of the ice crystals is developed into an endless variety of forms. Messrs. Lowe and Glaisher have delineated some hundred examples of these figures. In place of the solid prisms peculiar to the system of crystallization, these are flat, patterned, stars of six rays, grotesquely ramified, and having diameters of a twelfth or even a tenth of an inch. They are the skeleton-bases of regular prisms, which, grouped together, form the downy material of a snow-flake.

Thus it is that conditions in the depth of winter are quite unfitted for the formation of hail; but in the microscopic ramifications of the snow crystals we also perceive a plausible reason why lightning and thunder should not in the winter season accompany falls of snow, as they so frequently do in summer those of rain and hail. The large surface and the numerous acute points which these crystals present, are, in all probability, means sufficient for the complete and rapid dissipation of the electricity which they accumulate by their assemblage.

SATURN'S RING.—DOUBLE STARS.—OCCULTATIONS.

BY THE REV. T. W. WEBB, F.R.A.S.

SATURN'S RING.

Our evening skies are losing much of their attraction in the departure of Jupiter and Saturn into the strong twilight, where it will be scarcely worth while to follow them. The globe of the latter is still bisected by the line of the dark side of the ring, the breadth of which* will rapidly diminish during the month, as the earth's annual movement carries us nearer to its plane, till, on July 28th, it will amount only to 0″.085, preparatory to its entire disappearance edgeways on August 12th, after which time the N. side comes permanently into view for 15 years. We intend, shortly, to give some account of the very interesting transits of the shadow of the 6th satellite which have been recently observed: unfortunately its approach to the sun will now put this phenomenon beyond the reach of any but the most powerful instruments. Mr. Dawes has detected with his $8\frac{1}{4}$-inch object-glass a "very faint gleam of coppery light" in the place of the ansæ, as in 1848; but he has been surprised at the non-appearance of the shadow of the ring, an additional proof of its "almost inconceivable thinness," or of its possessing an atmosphere sufficient to convert its shadow into a mere penumbra. As the sun is, however, now rising higher above its N. side, he says (May 22) that in a few weeks it will probably become distinctly visible as a black line S. of the projected ring, and he calls upon the possessors of powerful instruments to watch the time of its first appearance.

DOUBLE STARS.

We proceed with our list of such of these objects as will not bear delay, unless we can resolve to rise long before the dawn in the early spring. Our first is a very remarkable star:—

11. *α Scorpii. Antares:* supposed to be so named as equivalent in colour to *Ares*, the Greek name of Mars. Scorpio will be easily identified as a fine group of tolerably bright stars near the S. horizon, which, on account of its low elevation, should be examined as soon as the twilight will admit of it. The most conspicuous amongst these is Antares, both in respect of its magnitude and its colour, being the reddest of all the larger stars in the heavens. Smyth calls it fiery red. With

* This breadth was given much too large in the Intellectual Observer for May, the *whole minor axis* (= 2″·04) having been inadvertently substituted for the part visible in front of the ball.

my $3\frac{7}{10}$-inch aperture the disc appeared yellow, surrounded by flashes of deep crimson, mixed, or rather alternating, with a smaller quantity of beautiful green rays. My attention was called to this peculiarity by an old observation of Dr. Forster, in which he stated that he had "observed a remarkable changing of colour in Antares: for a second or two of time it appeared of a deep crimson colour, then of a whitish colour; then the crimson was resumed," the red colour being irregular both in its alternations and continuance. He ascribes a similar phenomenon, in a less degree, to Betelgeuze, Aldebaran, and other red stars. The attendant registered by Smyth is very distant, and I have not entered it; but a much more interesting discovery has since been made by Professor Mitchell with a 12-inch Munich refractor at Cincinnati, U. S., of a very near bluish-green companion; thus constituting it the only close double star of the first magnitude hitherto known. Our astronomer royal thought it would be impossible to see it in England, but it was detected by Dawes several times with a $6\frac{1}{2}$-inch object-glass, and found to have a distance of about $3''{\cdot}5$, and an angle of $273°{\cdot}17$; and on March 27, 1856, he saw it with 8-inches under most interesting circumstances, emerging from behind the dark limb of the moon, about 7ˢ before the principal star appeared; it was thus proved that its magnitude was about the 7th, and its colour independent, and not, as might have been supposed, the effect of contrast. The following remark by this great observer is worthy of attention:—"If the angle of position were nearly coincident with the meridian, it would be almost impossible to observe the small star in these latitudes, as the bright star forms a strong prismatic spectrum in that direction. This atmospherical effect may, however, be in a great measure counteracted by using a single lens as an eye-glass, or by the ordinary double micrometer eye-piece. The star being placed towards the southern (upper) side of the field of view, the eye-piece spectrum may be made very nearly to neutralize the atmospheric spectrum, and a very tolerable image obtained under favourable circumstances." Hippisley also has seen the *comes* twice with a $9\frac{1}{4}$-inch Newtonian, and his remark likewise is deserving of being cited, as to "the great value of the half-hour at and after sunset, for the more delicate and difficult observations in all cases where the object has light enough to be well visible telescopically by daylight, such as exists at that period. This may probably arise from the short equilibrium between the heat of day and the chill of evening; during which atmospheric disturbances, arising from the intermixture of beds of air of different temperatures and densities, may be expected to be at a minimum." Secchi, after several failures, which led him to

suspect variable light, saw the companion perfectly with the great achromatic at Rome; and I have been informed by a correspondent, that under very favourable atmospheric circumstances he has seen it distinctly with as small an aperture as $2\frac{3}{4}$ inches. It is evidently not difficult from either minuteness or closeness, but merely from its low elevation, and the blaze of its superior: but should we fail to detect it, we shall assuredly not regret a nearer acquaintance with so superb an object as the great star—a fiery sun, the quality of whose light, so totally dissimilar to that of ours, must, to our apprehension, induce an equal disparity in the development of vegetable and animal life in the system subjected to its influence. There are many other instances of stars of an equally deep or even deeper red, but they are for the most part only visible with the telescope, and as Sir J. Herschel observes, are *insulated*. It will be peculiarly interesting to ascertain whether Antares is physically or only optically connected with its companion.

12. *β Scorpii*. 13″·1. 24°·9. 2 and $5\frac{1}{2}$. Yellowish white and pale lilac. I fancied the smaller star greenish with $3\frac{7}{10}$-inches, 1850·46. This is a magnificent pair, though apparently optical only. It is the brightest star *n p α*.

13. *σ Scorpii*. 20″·5. 271°·6. 4 and $9\frac{1}{2}$. Dusky white and plum-colour. Sestini called the companion white, 1846·5. Easily found from Antares, which it precedes about 2°, a little *n*.

14. *ν Scorpii*. 40″. 338°·5. 4 and 7. Pale yellow and dusky hue. This "charming object," as I have entered it, follows *β* at about 2° distance, a little *n*. Smyth records it as above, but Jacob found, in 1847, that the small star has an 8 mag. companion, at a distance of 1″·75, which, though not seen by Sir John Herschel at the Cape, is an easy object with my $5\frac{1}{2}$-inches, and renders the combination still more beautiful.

15. 51 *Libræ* (alias *ξ Scorpii*). 7″·2. 76°·1 (1834·42). 7″. 68°·1 (1846·49). $4\frac{1}{2}$ and $7\frac{1}{2}$. Bright white and grey. This is a highly interesting object, being really triple, a 5 mag. star, pale yellow, lying close to $4\frac{1}{2}$. Smyth gives for it 1″·4, 6°·6 at the earlier, 1″, 24°·9 at the later epoch. Hence it is evident that under the aspect of a single star we have a binary pair before us in rapid motion. It is to be regretted that it is now too close for ordinary telescopes. With $3\frac{7}{10}$-inches of aperture, its elongation was very doubtful as far back as 1851; Secchi found it but 0″·463 in 1855; and if there is sufficient ground for Theile's computations, the distance would be only 0″·018 in 1860, after which it would speedily widen, attaining 1″ in 1870. He gives a period of 44 years, or 49 by including Herschel I.'s observation in 1782. Jacob prefers 52 years. The more dis-

tant companion is also undoubtedly in motion, and is probably connected with the others, forming a wonderful system of self-luminous bodies, whose mutual relations are to us quite unintelligible. There is another smaller pair, 8 mag. *s* a little *f*, followed by an 11 mag. star; the whole making up a very beautiful group. It may be found thus:—When β Scorpii (No. 12) is on the meridian, a remarkable pair of 3 mag. stars, δ and ϵ Ophiuchi, otherwise *Yed*, the *hand* of the figure, will be seen nearly over it, almost twice as far from it as Antares. 51 Libræ is a little to the right, and rather above the centre, of a line joining β Scorpii and this pair.

16. ρ *Ophiuchi*, 3″·8. 3°·1. 5 and 7½. Pale topaz and blue. This very beautiful object, which may perhaps be in motion, is finely grouped with two 7 mag. stars, 68 and 72 P. XVI., that is to say, the 68th and 72nd in the XVIth hour of Right Ascension in Piazzi's great Palermo Catalogue—pointing out two angles of an equilateral triangle, of which ρ occupies the centre. It lies 3° *n* from Antares, a little *p*. The star maps of the S. D. U. K. include it in the boundary of Scorpio.

17. 36 *Ophiuchi*, 5″·2. 226°·1. 4½ and 6½. Ruddy and pale yellow. This is supposed to be a binary pair, and the larger star has been thought variable: when I observed it (1854·34), it certainly was but little brighter than its companion. A 7½ mag. star forms with it a triple group. It appears certain that it has a motion through space, in the same direction, and to the same amount, with 30 Scorpii, which is more than 13′ distant *n f*. Should this indicate a real connection, how marvellous an instance is before us of influence exerted through distances which human faculties refuse to comprehend, and where we can only wonder and adore! This pair is due E. at a considerable distance from Antares, nothing conspicuous intervening, with a brighter star, θ Ophiuchi, *n f*, about 2° distant.

18. 39 *Ophiuchi*, 12″·1. 356°·2. 5½ and 7½. Pale orange and blue, 1838·52. Sestini called the companion yellow in 1846·5: Smyth's review made it bluish in 1851·4, and I entered it "clear blue" three years later. This beautiful pair, which shows no movement, is 1° *n p* from θ (see last No.) Near it was the wonderful New Star of 1604, discovered Oct. 10th, at Prague, by Kepler's pupil, Bronowski, and seen by Kepler on the 17th. It was white, and more brilliant than the brightest stars or even planets, Venus alone excepted; but when it reappeared as a morning star at the end of the year, it had already begun to diminish; it continued to decay through 1605, and never came round in the morning again, nor has any trace of it been since recovered. Only two phenomena of the kind have recurred since the invention of the telescope, and both were far inferior; one near β Cygni was only 3rd mag., and Mr.

Hind's New Star in 1848, which broke out at no great distance from the place of that in 1604, barely surpassed the 5th mag.; but as an equally, if not more conspicuous star blazed forth in Cassiopea in 1572, and there are obscure relations, especially in the Chinese records, of similar events in earlier ages, we are warranted in not despairing of witnessing such a glorious sight again, and possibly of getting some approximate idea of its distance and magnitude. Thus far only we can see at present that both must be immensely great, as such phenomena undoubtedly lie far beyond the planetary system, and in the true region of the stars. Imagination shrinks from the contemplation of the impenetrable mystery of their nature, not without some appreciation of the astounding magnitude of the change indicated by so sudden an evolution of most vivid light, and probably corresponding heat also. Whether the new star in the 2nd century B.C., which we are told induced Hipparchus to form the first catalogue, was of this character, seems doubtful. It is strange that among all the authorities whom I have consulted, not one, excepting Humboldt, alludes to the curious fact that Pliny, from whom we have the story, expressly ascribes *motion* to the new object;* Humboldt, who was aware of it, has not much confidence in Pliny's "rhetorical style;" but the expressions of the latter seem as explicit as could in reason be expected.

Having now reviewed the principal double stars near the S. horizon, we will proceed to a constellation—*Böotes*—which will be in sight some time, but part of which we had better take at once, since work will crowd upon us as the days decline. And here Arcturus (*α Böotis*) shall be our guide. Every observer will easily recognize him at a considerable height in the S.W. sky, as one of the most conspicuous ornaments of our summer evenings. Wega, further E., and near the zenith, alone rivals, with its lovely sapphire beam, this glowing topaz. Observers have differed as to their precedency. In 1806, Sir W. Herschel gave the preference to Arcturus; and his son has done the same in the proportion of 718 to 510; Seidel, on the contrary, in 1846, with Steinheil's photometer, gives Wega 100, Arcturus 84. Photometry, however, is confessedly in an imperfect state; and it is not only possible, as Smyth remarks, that "colour may interfere with our exact perception of size," but it has been shown by Argelander and Pogson that in the case of red and white stars there is a considerable difference in the estimates of different eyes and telescopes. Fletcher has also found that the light of Arcturus is slightly variable. On the whole, how-

* Novam stellam et aliam in ævo suo genitam deprehendit: ejusque motu, qua die fulsit, ad dubitationem est adductus anne hoc sæpius fieret, moverenturque et eæ, quas putamus affixas.—*Historia Mundi*, ii. 26.

ever, Arcturus will probably be generally owned as the leader of the northern hemisphere: and in accordance with this, it happened to be the first star seen by Morin, in 1635, in broad daylight; as Morin was perhaps the first observer of stars under such circumstances. Schmidt, formerly of Olmütz, but at present director of the observatory at Athens, has asserted that Arcturus has changed its colour; he had for 11 years considered it one of the reddest stars, and had, in 1841, compared it with the planet Mars; but in 1852 he was surprised to find it yellow, without a trace of red, and whiter even than Capella to the naked eye. This alteration seems unconfirmed by his contemporaries, but the subject is a curious one, as such a change appears to be more than probable in the case of Sirius. In another respect Arcturus is peculiarly interesting, as possessing so great an amount of proper motion: its position alters annually 2″·25 towards the S.W., so that supposing its rate to have been invariable, it must have traversed a space equal to about 7 diameters of the moon, since the creation of man. This extraordinary displacement might be taken as an indication of comparative nearness to our system, and might be wholly or in part ascribed to a contrary motion on the part of our sun, did not the extreme minuteness of the parallax of Arcturus (about 0″·169 according to Johnson) demonstrate its astounding distance, requiring 19 years for the transmission of its light to our eyes; and prove at the same time its incalculable velocity and enormous magnitude. This is a golden sun indeed—the centre, probably of a magnificent system of attendant worlds. It is a grand object in the telescope, but though we have deservedly given it some attention, it is but an intruder in our list, and we proceed to

19. ε *Böotis*, 2″·9, 321°·2. 3 and 7. Pale orange and sea-green. A pair well deserving of Struve's epithet "pulcherrima," and long celebrated as a test of the goodness of telescopes. The recent extension of their size and power now demands a more rigorous criterion, but it is still very useful for trying smaller instruments. An aperture of $2\frac{3}{4}$ inches ought to bring it out; I have seen it as a known object, but do not suppose I should have discovered it, with $2\frac{1}{4}$. W. Struve* thinks there is no doubt of this pair being in slow motion, but Smyth does not consider the question decided. This object is closer than any that we have as yet attempted, and may be considered as our first introduction to a more difficult class, requir-

* It has been recently announced that this distinguished observer, who has rendered such eminent services to sidereal astronomy, has resigned the post of President of the Imperial Observatory at Poulkowa, near St. Petersburg, which he has worthily filled for many years. He is succeeded by his son M. Otto Struve.

ing greater instrumental and atmospheric advantages. We may therefore here suitably introduce, for the encouragement of the beginner, Sir W. Herschel's remark, already exemplified in the case of Mizar, No. 1—that when first seen, such objects "will appear nearer together than after a certain time; nor is it so soon as might be expected, that we see them at their greatest distance. I have known it take up 2 or 3 months, before the eye was sufficiently acquainted with the object to judge with the requisite precision."

ε may be easily found from our *pointer*, Arcturus, being the next moderately bright star *n f*, or nearly over it as it is declining in the S.W.

20. ξ *Böotis*, 7″·3. 332°·1. (1831·53). 6″·9. 332°·9 (1842·42). Secchi found it 6″, 1855·419. $3\frac{1}{2}$ and $6\frac{1}{2}$. Orange and purple. This is a very interesting pair, undoubtedly binary, and revolving probably in a highly elongated ellipse, lying very obliquely towards the eye, with a period given by Sir J. Herschel at 117 years. It will be found nearly due E. of Arcturus, forming with it and ε an almost rectangular triangle, the greater angle being at ξ. It is also the uppermost of a crooked row of four stars bearing downwards, whose position must be noticed, as we shall call up two more of them.

21. π *Böotis*, 6″. 99°·3. $3\frac{1}{2}$ and 6. White: a ruddy tinge seems, however, to have been sometimes noticed in the smaller star. A beautiful pair, though stationary. An alternate view of this and the preceding object forms an interesting study of colour. It may appear surprising that with so much general similarity the one pair should be moving, the other fixed, and apparently optical. It is, however, possible that π may be hereafter found to be binary, its motion, much slower than that of ξ, from inferior density, or from greater mutual distance reduced in apparent amount by greater distance from ourselves, being for the present masked by the position of the companion, at the end of an ellipse foreshortened into a straight line. The concurrence of all these conditions is certainly very improbable, but it is well to be aware of their possibility.

π is the 3rd star, counting downwards, of the crooked row beginning with ξ.

22. ζ *Böotis*, 1″·2. 127°·3. $3\frac{1}{2}$ and $4\frac{1}{2}$. Bright white and bluish white. Struve asserted that they were alternately variable; but Smyth could not perceive it. This pair forms our first instance of a really close object, and is in fact far too difficult for the generality of small instruments, though its separation has been accomplished by one of Ross, senior's achromatics, having an object-glass of only $3\frac{3}{8}$ inches. My $3\frac{7}{10}$ inches would strongly elongate, but not actually divide it; this, however, was effected by Dawes's celebrated Ormskirk telescope by

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Dollond, which had $\frac{1}{10}$ more aperture, and a most exquisite correction. Secchi, in 1855, with the grand Merz achromatic at Rome, gave it but 0″·978 of distance, and it must be owned that its aspect is entirely that of mutual connection, but it is generally considered stationary; and this fact renders it a most useful criterion for instruments of moderate size, as the rapid motion of many test-objects is continually altering their value. ζ is the lowermost, and somewhat the brightest of the "crooked row."

To give the smaller instruments their turn, we will conclude our present section with

23. δ *Böotis*, 1′ 50″. 75°. $3\frac{1}{2}$ and $8\frac{1}{2}$. Yellow and light blue, or lilac. Wide as this object is, it is pleasing from the contrast of colour. To find it, run a line from Arcturus through ε, and carry it nearly as far again.

OCCULTATIONS.

The occultation of a considerable star by the moon, especially its disappearance behind the dark limb, when rendered sufficiently visible by the earth-light, is a striking phenomenon. Though the different positions of the moon in the sky, night after night, sufficiently show the rapidity of its orbital motion, it is much more impressively brought before us, when a fixed mark enables us to trace its steady advance minute by minute; and there is something extremely grand and beautiful in the smooth, swift motion of that ponderous globe, so perfectly balanced in free space, and urged so uninterruptedly onward by the Creator's power. Occultations, especially of telescopic stars, are constantly taking place, but the majority of them are invisible or inconvenient from the hour, or inconspicuous from the star's minuteness or the moon's brightness. The beginner may be reminded that in these cases, if he lives far N. or S. from Greenwich, the specified times, even though corrected as they require to be for difference of longitude, will not be found accurate; for owing to the moon's comparative nearness to us, each county in England refers her at the same moment to a different position in the sky, and brings a different part of her limb in contact with the star, occasionally raising or depressing her apparent path sufficiently to let the star, occulted at Greenwich, escape entirely free. The country observer, therefore, especially in situations far N., must expect discrepancies, and look out in time, as the event may anticipate the tables. Extinction and reappearance are usually instantaneous. I once (May 19, 1858) witnessed the great star Regulus *snuffed out* in a moment, and a grand sight it was, especially as the telescope (an achromatic exhibited by Slater, in Euston Road, Islington), had upwards of 14 inches of aperture. But in some

cases gradual diminution has been observed, which may probably be ascribed to the impinging of the star upon the limb where its general direction, or that of some precipitous slope upon it, forms so small an angle with the moon's path, that the star, whose real (not *spurious* or optical) disc, however minute, must have *some* magnitude, is hidden by slow degrees, and thus the existence is manifested of a quantity too small, hitherto, for the finest telescopic vision. The strange phenomenon of *projection* is occasionally witnessed, when a star, instead of passing at once behind the limb, seems to glide in front of it for a short distance before it disappears. Much attention has been paid to this singular appearance by South, Airy, and others, but to little purpose; it seems to depend upon some illusion in the eye or the telescope; and though its recurrence from time to time is unquestionable, it can never be predicted on any occasion. The present month affords no very favourable specimen of occultation, but the following may be looked for:—

July 10th, 10h. 57m. 30 Sagittarii, 6 mag. This, only a near approach at Greenwich, will be an occultation further N. 11th (day of full moon), 57 Sagittarii, 5½ mag. Disapp. 10h. 22m. Reapp. 10h. 41m. 14th, κ Aquarii, 5 mag. Disapp. 10h. 21m. Reapp. 11h. 24m. 15th, 9 Piscium, 6 mag. Disapp. 10h. 29m. Reapp. 11h. 30m. κ Piscium, 4½ mag. Disapp. 10h. 31m. Reapp. 11h. 24m.

THE HURRICANE OF MAY 1862.

BY E. J. LOWE, F.R.A.S., ETC.

THERE is something very singular and startling in a hurricane. The suddenness of its appearance, the rapidity of its motion, and the devastation, which shows but too plainly where it has been, are points of special interest to the meteorologist. Unfortunately the exact pressure or velocity cannot be satisfactorily established; a rough approximation being the nearest approach to the truth of a violence so great that the anemometer or instrument used to measure a gale cannot withstand its fearful violence. We can register 10, 20, or 30 lb. pressure on the square foot, but a hurricane, which levels all before it, even sound and deeply-rooted oak trees that have withstood the storms of 200 years, requires something as strong as itself to enable us to record its violence. Fortunately these devastating visitants are not frequent in this country, and, more fortunate still, their violence is confined within narrow limits. The one we are about to describe was accompanied by a thunderstorm which was more or less spread over the centre of England,

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where in numerous places there was great destruction caused by the hailstones, but not by the hurricane except in the neighbourhood of Newark. Near Peterborough, the direction of the storm was from S. to N.E.; here, for one and a half miles in width, the crops were devastated by huge hailstones of three inches long, two inches wide, and half an inch thick, and much glass was broken. At Oundle, the crops were destroyed and the windows broken, which was also the case at Whittlesea, Eye, Thorney, Crowland, Leeds, Newark, and Whittington near Chesterfield. At Whittlesea, the storm began at three o'clock, and lasted till four o'clock, the wind being rough from S. At Crowland it began at 4 p.m. from S.E.; here the hailstones were from four to five inches in circumference. At Whittington, hail commenced falling at 4h. 45m., the wind W., veering to S., then to E., and by 5h. 45m. again W. At Eye, the storm raged from 3 till 4 p.m. At Buxton, the storm commenced between four and five o'clock, and by 5h. 45m. p.m. the darkness was too great to allow of reading or working, and gas was lighted; there was heavy rain but no hail. The lightning was first *blue*, then *peach*, *mauve*, or *rosy blue*. At Whaley Bridge there was a deluge of rain with sudden fierce S.W. gusts. At Walton (five miles from Wisbech) a sudden S.E. gale for a few minutes at 4h. 50m., the sky being very thick in the W. At the Middle Level Sluice, at 5h. 30m., there was a strong S.S.E. wind, with lightning, thunder, and large rain, which moderated at 6 p.m., going to the N.; strong S. wind till 7 p.m. At Wisbech at 6h. 15m. p.m. the darkness so great as to render it almost impossible to see close to a window; wind S.W. At Lea (two miles south of Gainsborough) continuous thunder from 4 till 6 p.m., at first over Lincoln; at 5 p.m. over Newark (where a dark lurid cloud rested), and after 6 p.m. over Worksop. The day was hot till 6 p.m. when a sudden W. breeze sprung up, and it became colder. No rain or hail. At Radborne (five miles N.W. of Derby) the storm came from S. bearing E., commencing at half-past four o'clock, and lasting till 6 p.m. Heavy rain but no hail, and the lightning never overhead. The course of the storm was from Burton. At Whittington (three miles from Chesterfield) hail commenced at a quarter to five o'clock with W. wind; some stones were four inches round and one and a quarter inches in diameter, weighing from a quarter to half an ounce, and breaking much glass. The wind soon veered to S., then to E., and in an hour was again W. At Chesterfield there was no hail. At Leeds the hailstones were seven inches in circumference. At Wath (near Rotherham) thunder commenced at a quarter past five p.m., and became continuous at a quarter to six; at half-past six very dark, a black cloud

extending from S.S.E. to W.S.W.; wind S.W.; storm over at a quarter past seven. At Silloth a storm at 10 p.m. At Shiffnel (Salop) there was no thunder but incessant rain, with a N.N.W. wind. At Ventnor also, and at Clayton, Hurst-Pierpoint, and Clifton incessant rain but no storm. At Sandgate (Kent), Tunbridge, Ramsgate, Gloucester, Byfleet, Barnstaple, and Aldershott there was no storm. At Kington (Herefordshire) incessant rain, and unusually dark, but no storm.

On the previous evening, it is worthy of remark that a violent thunderstorm was raging in the Isle of Wight, extending all the way to London. Also at Clitheroe, Tunbridge, Hurst-Pierpoint, Byfleet, Aldershott, Nottingham, Derbyshire, Leicestershire, Yorkshire, and Lincolnshire, accompanied with large hailstones and *rose* coloured lightning. At Highfield House there was continuous thunder all the afternoon in S. and S.E., from storms following each other in rapid succession in a S.W. current; at 4 p.m. the wind, which had been N., veered to W., and at ten minutes to eight a thunderstorm, in a S.S.E. current, commenced passing over, the lightning exceedingly vivid and very blue in colour. At eight o'clock, for two minutes, there was a hailstorm with stones of a conical form, and as large as nuts. Above an inch of rain fell. In half an hour this storm had passed over to N., but there was much lightning and heavy rain all night. The similarity in many respects of this storm with the one next day makes it desirable to mention it briefly.

And this leads us to the memorable 7th of May, a day that will long be remembered in Nottinghamshire, memorable for the hurricane near Newark, and for the violence of the thunderstorm in the neighbourhood and elsewhere, particularly striking from the *night-like* darkness, the great size and curious forms of the hailstones, and on account of the magnificence of the colour of the lightning. At Highfield House the morning was fine and sultry, about noon thunder was heard in the S.E., and again continuously in the S. and S.E. at 3 p.m. At half-past two the temperature in the shade had risen to 73·6° with a W. wind, but with clouds whirling round in all directions; a low current carried the broken nimbi rapidly from the W., whilst at the same time the storm-cloud was approaching in a S.S.E. current; at 4h. 30m. the temperature had fallen to 60° (a descent of 13·6° in two hours), whilst the wind had risen to half a gale. At this time in the S.E., low, long-rolling distant thunder gave ominous signs of an approaching storm of great magnitude. The sky gradually became blacker and blacker until, at five o'clock, it was darker than I had ever before seen it in the daytime, with the solitary exception of the total eclipse of the sun in July 1860, within the central path in Spain. A book

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could be scarcely read at a window, nor away from it could the time be ascertained by a watch. This storm put on very much the appearance of a total eclipse, all near objects had a yellowish glare cast upon them, and the landscape was closed in on all sides at the distance of half a mile by a storm-cloud wall. Rain fell in torrents, being swept along the ground in clouds like smoke. Flashes of lightning followed each other in rapid succession, four or five flashes following close upon each other, then a brief pause, and four or five more. The colour of the lightning was lovely beyond description, an intense tint of *bluish-red*, approaching *rose*, all the flashes being of the same hue. The lightning was too brilliant to look at without pain to the eyes, but when reflected on white paper, the colour was most beautiful, and indeed surpassed all known colours, as much as ultramarine surpasses ordinary blue. The wind now veered to the S. or S.S.E., taking the storm's direction. At 5h. 35m. the temperature had descended to 51° (a fall of 22·6°); the wet bulb being also 51°, the rain was however less heavy. The storm had mostly passed to the N.W., and the sky, more especially in the N.E., was considerably lighter. At 5h. 50m. the wind veered to W.N.W., and the temperature commenced rising. It is worthy of remark that the barometer was almost stationary, being no doubt held up by the great coldness of the storm in comparison with the surrounding air. At six o'clock the temperature had reached 53·3°, the wet bulb being 52·5°, and the wind W., the force having moderated from a pressure of 9 lb. on the square foot (at 5 p.m.) to a pleasant breeze. The storm had passed over us in a S.S.E. current, moving slowly across a violent W. wind. At six o'clock the clouds were in a S.E. current, except in the S.W., where they were in a N.W. current. The nearest flashes were a mile and a half off. At 6h. 15m. the storm was evidently sinking more westerly, the course having become S.E. and then E.S.E. At seven o'clock there was again distant thunder in the E., and at 7h. 15m. flying scud in a W.N.W. current moved with fearful rapidity, passing from overhead a distance of 45° in 42 seconds, a higher speed than I had ever before registered; at the same time a more lofty current carried clouds slowly from the S.E. 7h. 40m. lightning in the N.E., where the sky was again black. From 8h. 40m. till 8h. 55m. a gale, after which the wind moderated. The amount of rain was not excessive, viz. 0·665 of an inch. Several trees were uprooted, and the ground was quite white all over from the bloom torn off the apple-trees.

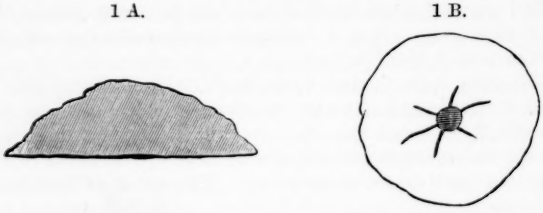
Severe as this storm was at Highfield House, it dwindles into insignificance when compared with its violence near Newark, where it was accompanied by a hurricane and hail-

storm similar to those occasionally witnessed in India. It is scarcely possible to imagine any destruction more complete than that effected by this fearful storm, but fortunately its ravages were confined within narrow limits. It appeared to commence at the village of Barnby, where a small barn was thrown down. After proceeding a mile, its force considerably increased, and just before reaching Coddington its course crossed a farm-house and buildings, which were unroofed. It then passed over several fields, tearing up the hedges. One of the fields was ploughed in ridges for potatoes; these ridges had entirely vanished, and the field was left perfectly level. As it crossed Balderton Lane it unroofed a farm-house and threw down the farm buildings, uprooting two enormous oak trees; a quarter of a mile further it unroofed the house of the head keeper of Mr. James Thorpe, of Beaconfield, breaking nearly all the windows, the hail-stones having in many instances been positively driven through the glass, cutting out a smooth hole without cracking the window-pane. The spout of this house—one too heavy for a man to lift—was carried a hundred yards. A perfectly sound tree, about 60 feet in height and 5 feet 10 inches in circumference (where broken off), was snapped asunder four feet from the ground, and the tree itself carried twenty-nine yards through the air. Although snapped off suddenly, it shows the circular motion of the storm, as the wood is twisted to the very heart of the tree. Near here a man was lifted off the ground, and carried twenty yards, finally being deposited in a hedge. From this point to Mr. Thorpe's house were many fine trees, all of which were torn up by the roots or broken off. About thirty or forty yards from the house the hurricane divided, as the house itself is intact, and also the trees in its immediate neighbourhood from S. round by E. to N. (a lilac tree not having its blossoms damaged); while on the western side outbuildings are unroofed and in some cases destroyed, the large garden wall thrown down, the greenhouses smashed, the fencing round the plantations broken off and carried into the fallen timber, and a heavy plank of wood lifted off the ground, snapped in two, one half lodging on the top of a building, and the remainder carried over it into the kitchen garden. A few yards beyond the house the divided gale reunited; its course now passed through a wood, where everything in its path was destroyed; then proceeding onwards a mile and a half reached Winthorpe, doing considerable damage to the grounds of Mr. Hodgkinson, M.P., and some little to those of Mr. Marfleet. A short distance further and its fury became exhausted. The greatest violence was restricted to about three miles in length, and its extreme breadth was from 100 to 150 yards, except near Coddington, where, for a short

distance, it was much broader. The course was from S.S.E. to N.N.W., being almost a straight line.

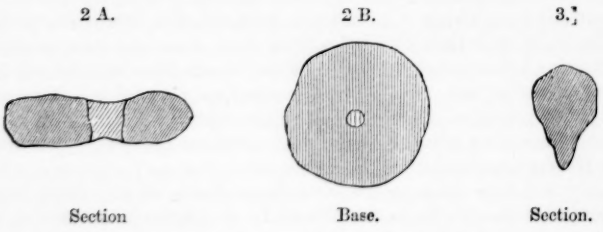
Mr. A. Stevenson, of Tynemouth, who was visiting Mr. Thorpe at the time, was an eye-witness of the storm, and from him I derived the following valuable information. He says that "at 3·30 p.m. there were mutterings of thunder. From 4 p.m. till 4·30 heat oppressive; about 4·45 and till 5 exceedingly large and curious hail fell; they were of four shapes.

1st. Hemispherical, clear like ice, except the central point,



which was opaque, and from which semi-opaque lines radiated along the base. The diagrams represent the average size; some were a little larger. Of these only a few fell near Beaconfield.

2nd. Flattened spheres, more numerous than the first,



semi-opaque, with hard white centre, thinner at the axis than at the circumference.

3rd. Opaque and pear-shaped. These were numerous.

4th. Ordinary circular hail-stones, opaque and softish.

On the falling of these hail-stones the air became chilly.

At about three minutes past five o'clock, on looking out of a window facing the E., Mr. Stevenson's attention was attracted by seeing a small pony, closely followed by the sheep and cattle, rushing in terror and at great speed from the S.S.E. Opposite the house the pony stopped and looked back, and then started off at still greater speed, as if pursued. On

looking in the direction from which the cattle came, he saw the sky quite obscured by a strange dark wall of cloud, which was approaching; then a large quantity of hay and straw, which seemed to fill the air, followed by clouds of the blossom of the horse-chesnut and small twigs; then at once, with a roar which is indescribable, came a furious blast, which seemed as if it would sweep the land of all which stood on it. Great trees went down before it torn up by the roots, levelled as if by a sudden blow. The impression was that the house must be swept away. This continued rather more than a minute, and was accompanied by gleams of lightning so frequent as to seem continuous. When it passed there was a torrent of rain, with extremely vivid lightning.

The gardener, who was out in this storm, says that he observed it hurling down the trees to the south of him passing by, and then throwing them down in the north; and that from where he stood, he considered that in two minutes every thing was destroyed within his view, which extended a mile and a half.

My brother, who was with his regiment about a mile from Beaconfield, describes the storm-cloud seen from this distance as tapering to a point like a waterspout, and exceedingly black and dense. He measured many hail-stones an inch and a half in diameter, and some few were larger. He says the hail fell with great force, yet not with sufficient violence to pass through glass without cracking it; it was, therefore, the force of the gale that propelled them like bullets shot from a rifle. These bullet-like holes were drilled through the windows both on the east and west side of the house, showing the circular movement of the air. From the keeper's house I had several of these panes of glass cut out of the windows, in order to preserve them. I also procured the circular pieces of glass that had been punched out.

It is interesting to observe that, whilst at Highfield House there was a gale from the W. of nine pounds pressure on the square foot, at Beaconfield the hurricane was in a S.S.E. current, and that whilst the hurricane was passing the wind changed to this quarter, and then returned to W.N.W. Probably these gales combined, and the southerly one being the most powerful, a rotation was caused moving in the direction of W. to S. That this was the case was very readily proved on examination, not only from the direction of the twist of the wood on the snapped-off trees, but from an avenue of chesnuts situate on the extreme eastern edge of the hurricane, all the torn-off boughs lying on the S. or storm side, and carried back beyond the level of these trees. Then, again, the dividing of the hurricane at Mr. Thorpe's house was a further proof of the rotation

being from W. to S., as no doubt the substantially-built house and stables to the W. of it saved the trees, yet those left standing were such as would have received no protection if the force had been either *direct,* or if it had rotated from S. to W.

The fall of 22°·6 of temperature in two hours at the Highfield House Observatory (twenty miles away) was no doubt owing to this gale.

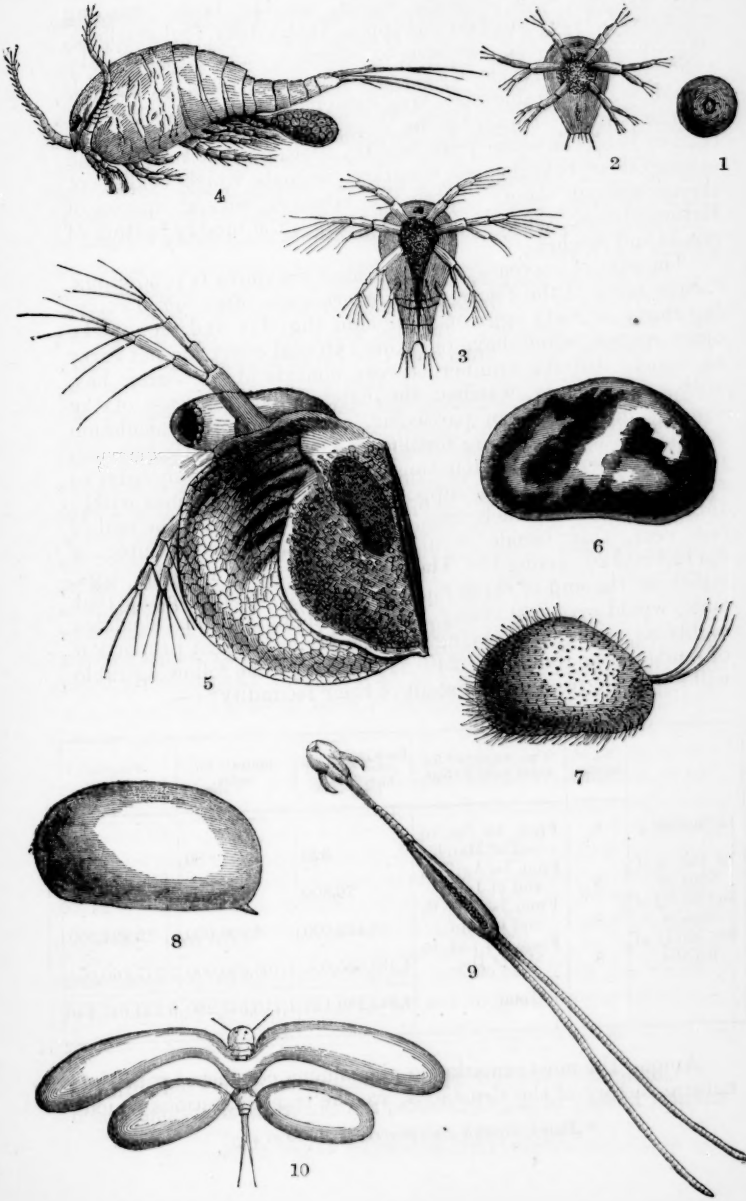
A number of photographs were taken along the path of the gale with "Dr. Hill Norris's Dry Plates." I name this as these plates had previously travelled with me to Spain in July 1860, and although this box was only opened in May 1862, they were in excellent condition.

ENTOMOSTRACA* (WATER-FLEAS).

BY G. S. BRADY, M.R.C.S.

Among the many groups of minute organisms to which microscopic observers are accustomed to devote their attention, there is scarcely any that is more calculated to interest the student inquiring into the curiosities of animal life, or to fascinate one who seeks only for amusement from the employment of his microscope, than that which embraces the strange beings known as Entomostraca. They are objects too particularly easy of access to almost everyone; for wherever water is they are abundant. It is, indeed, scarcely possible to dip a net into any weedy pool without bringing out of it some examples of the tribe; though probably in this case only common species, such as *Cyclops quadricornis* or *Chydorus sphæricus*. These two animals must be known by sight, if not by name, to every one who has examined microscopically a drop of water from a stagnant pond. And not only in fresh water do Entomostraca abound; they exist, likewise, in prodigious numbers in the sea, in brackish waters, and even in the concentrated brine of salt mines. Many species are parasitic on the skin, gills, and eyes of fishes, and some are found living even in the interior of zoophytes, etc. Though thus almost ubiquitous in habitat, they are seldom found in rapidly-running streams—delighting rather in the clear, still and sweet waters of lakes and large ponds: these, when

* The class Crustacea is divided as follows:—*Podophthalma*, or stalk-eyed Crustacea (crabs, lobsters, etc.); *Edriophthalma*, or sessile-eyed Crustacea (sand-hoppers, etc.); *Entomostraca* (water-fleas, fish-lice, etc.) By some authors the *Podosomata*, or sea-spiders, and the *Cirripedia* (Barnacles), are included amongst Crustacea. The *Rotifera* have also been considered to belong properly to this class, but probably with less propriety. Mr. Gosse, who has paid great attention to them, thinks that they have closer affinity with the insects.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well supplied with growing weeds, are the best "hunting grounds." It is a mistake to suppose that a dirty, foul-smelling, stagnant pool is the likeliest to afford a rich harvest to the collector in any branch of natural history; a pond, to be good, should be of tolerable size, long-established, and stocked with aquatic plants. These, by the constant liberation of oxygen, tend to keep the water pure, besides affording food and a home among their branches to countless animals which could not thrive without them. There are, however, several species of Entomostraca, whose congenial habitat is the muddy bottom of ponds and ditches.

The rate of increase amongst these creatures is prodigious. "Specimens of the *Cyclops quadricornis* are often found carrying thirty or forty eggs on each side (fig. 4); and though the other species, which have only one external ovary, do not carry so many, still the number is very considerable. Jurine has, with great fidelity, watched the hatching and increase of the *Cyclops quadricornis* in particular, and has given a calculation which shows the amazing fertility of the species. He has seen one female isolated lay ten times successively; but in order to speak within bounds he supposes her to lay eight times within three months, and each time only forty eggs. At the end of one year, this female would have been the progenitor of 4,442,189,120 young!! The first mother lays forty eggs, which at the end of three months, at eight layings during that time, would give 320 young. Out of this number he calculates eighty as males (there being in every laying a great proportion of females) the remaining 240 as females. The following table will show the prodigious extent of their fecundity*:—

	No. of layings.	Time employed for these eight layings.	Each laying supposed to be of forty young.	Subtract for males.	Females remaining.
1st mother .	8	From 1st Jan. to end of March,	320	80	240
1st family of females .	8	From 1st April to end of June,	76,800	19,200	57,600
2nd family of females .	8	From 1st July to end of Sept.	18,432,000	4,608,000	13,824,000
3rd family of females .	8	From 1st Oct. to end of Dec.	4,423,680,000	1,105,920,000	3,317,760,000
		Total . . .	4,442,189,120	1,110,547,280	3,331,641,840

Among the most remarkable phenomena connected with the natural history of the Crustacea, are the transformations which

* Baird, *British Entomostraca*, p. 189 *et seq.*

the young undergo from the time of their escape from the ovum to the attainment of their fully matured specific form. And it is of the highest interest to remark, that in obedience to a law which, if not universal, is at any rate widely prevalent in the animal kingdom, these temporary or larval forms are themselves closely analogous to the *perfect* forms of groups still lower in the scale of nature; so that many of these undeveloped beings were formerly, before their life-history was known, classed as distinct species, in a position very far from that which they are now seen to occupy. These changes have been closely studied in the common shore crab (*Carcinus mœnas*). The embryo of this species before, and for a short time after, its liberation from the ovum, presents both in size and general outline a strong resemblance to some Entomostraca. In this stage it was of old assigned to a distinct genus under the name of *Zoea*, and having undergone a still further transformation was called *Megalopa*. In this latter stage it puts on somewhat the appearance of the "lobster-crab" (*Galathea*), and after another step attains its true crab form, being the highest development of which it is capable. These changes are not produced gradually, but by a succession of "moults," the animal becoming for a time sluggish, casting its hard covering, and reappearing in a new guise. It is a well-known fact that the after-growth of crustacea is carried on by the system of moulting—the hard calcareous case of the animal preventing its growth in any other fashion. And as in the higher orders of Crustacea, so also amongst the Entomostraca, are transformations of this kind constantly apparent. For example, let us take the same species which we have just noticed as a characteristic instance of reproductive energy—*Cyclops quadricornis*. When first born, these little creatures (figs. 1, 2) are totally unlike their parent, being of an ovoid shape, and having only two short antennæ and two pairs of feet; but by three moultings the animal reaches its perfect form, having then two pairs of antennæ and five pairs of feet, besides which the body is seen to be divided into several distinct rings or segments. These changes will be best understood by reference to the plate (figs. 1, 2, 3, 4), the drawings in this instance being copied from Dr. Baird's work. The length of time occupied by these changes varies much according to the temperature. In February and March, Jurine found it to extend over twenty-eight days, whereas Dr. Baird has seen the process completed in eleven days during the warm weather of June.

Among the many interesting phenomena connected with the reproductive process in the Entomostraca, there remain one or two which we cannot pass over without brief notice. It is in members of this group that several of the most un-

doubted instances of Parthenogenesis * occur. It is certain that with many species one copulation is sufficient to impregnate the female for life. And not only this, but that the young which she produces are likewise fecundated and capable, without further impregnation, of continuing the species for many successive generations. In *Chydorus sphæricus* (a common form), Jurine observed the process through *fifteen* generations, and through *nine* in *Alona quadrangularis*. Dr. Baird has followed up the successive generations in *Daphniæ Pulex* as far as the *fourth* in the *Daphnia* born from the ordinary ova, and as far as the *third* in those born from ephippial eggs. These ephippia, or "winter eggs" require, probably, a few words of explanation. They are, in fact, ova covered with envelopes of more than usual hardness and thickness, and thus enabled to withstand an excess of cold, which would surely prove fatal to the parent. They are borne (in the *Daphniæ*) near the back of the shell in a considerable open space termed the matrix. (Fig. 5 represents *Daphnia rotunda* bearing an ephippium.) Here they may be seen in the form of a dense mass of hexagonal cells, through which appear one or two oval bodies, each of which contains an ovum covered with a shell. The ephippium with its enclosed eggs is set free at the fifth moulting of the animal, and floats on the water until spring, when the young are called into active life by the rays of the "world-reviving sun." The authors of the *Micrographic Dictionary*, however, reject this theory of the use of the ephippia, saying:—"The formation of this coat can scarcely have any relation to temperature, either from its structure, or from its requirement in an organism which *has no heat to retain*. Its presence would be perfectly intelligible, however, as a means of protection from evaporation when the pools become dry; and for this purpose its structure is well adapted. It might also afford a protection against the attacks of predatory animals, many of which could easily devour an ovarian ovum, while they could not break through the horny cases of the winter ova; and these winter ova are only formed when the ova are not to be hatched soon after extrusion from the parent." It is somewhat startling to read in a scientific work of animals which "have no heat to retain." Why, even a block of ice has heat in it, and although Entomostraca are what we call "cold-blooded" animals they are only *relatively* so, and cannot bear more than a moderate decrease of temperature with impunity. If these winter-eggs are meant chiefly as a protection against drought and not against cold, it seems strange that they should not be most

* For further information on this subject see Owen's *Lectures on Parthenogenesis*, and Dallas's Translation of Von Siebold on *A True Parthenogenesis in the Honey Bee and Silkworm Moth*,—the last a most interesting work.

abundant during the hot summer months when pools are most subject to be dried up. Moreover, it is probable that in many cases the animals themselves would bear such a desiccation without loss of life. Thus Dr. Baird "has found, upon examining ponds which had been filled again by the rain after remaining two months dry, numerous specimens of the *Cyclops quadricornis* in all stages of growth." It seems, indeed, to be almost a condition of existence with some species that their habitats should be exposed to alternations of wet and drought; as for instance *Chirocephalus diaphanus*. This, which is one of the largest (being upwards of an inch in length), and certainly the most beautiful of Entomostraca, inhabits cart-ruts and shallow pools mostly near the edges of plantations, but never any, so far as I can learn, which are not liable to be dried up easily. The *Chirocephalus* is rare in Britain, most of the known localities for it being in the south of England. The only living specimens I have seen were taken at Tillmire, near York, the most northern point at which it appears to have been hitherto found. Some species are much more susceptible of cold than others. For instance, *Polyphemus pediculus* is killed on the first approach of frost, while the *Daphniæ* and *Cyclops* may be found living the winter through, and, indeed, may be positively frozen and yet recover. For the following interesting table, exhibiting the effect of temperature on the species of Entomostraca, I am indebted to the Rev. Alfred Merle Norman. The table shows the number of species taken at a single gathering in the same piece of water, during the successive months of 1861:—

January (after the intense frost of 1860-61)	4 species.	July	14 species.
February	7 „	August	? „
March	7 „	September	17 „
April	17 „	October	17 „
May	10 „	November	10 „
June	? „	December	12 „

Mr. Norman remarks that the deficiency in the May number may perhaps arise from the day when the gathering took place not having been fine, the animals for that reason withdrawing into deeper water. While thus tolerant of all but very intense cold, it is interesting to note that Entomostraca will also live and thrive in water of very considerable heat. There is a reservoir connected with the engine of the Monkwearmouth colliery, the water of which is somewhat irregular in temperature, but mostly sufficiently hot to steam profusely. On one occasion I found the heat to be 100° Fahrenheit, and I suppose this may be taken as about the general temperature of the water. A pond-weed (*Potamogeton perfoliatus*), and a *Callitriche*, grow

freely in this hot bath (though their stems and leaves are plentifully encrusted with a deposit of calcareous matter), and sporting amongst the vegetation are myriads of Entomostraca, belonging chiefly to two species, *Cypris aculeata* (fig. 7), and *Cypris strigata* (fig. 6), the former, I believe, hitherto unknown in Britain. Beside these there were found *Cypris vidua, Candona reptans, Daphnia vetula,* and *Cyclops quadricornis.* It is worthy of remark that the two latter species were of stunted growth, while all the bivalve species (*Ostracoda*) attained a fine development. But it is not only under extreme conditions of heat, cold, and drought, that these creatures are capable of existence. We find at least one species which luxuriates in a *brine* strong enough to destroy almost any other animal. This is the *Artemia salina,* a species approaching in form the beautiful *Chirocephalus diaphanus* before alluded to. It is found abundantly in the brine-pits at Lymington in Hampshire, and it is remarkable that it is only in the most concentrated brine—containing four ounces of salt in the pint—that it makes its appearance. It is said that even if this solution be slightly diluted by rain the animal disappears. "During the fine days in summer they may be observed in immense numbers near the surface of the water, and as they are frequently of a lively red colour, the water appears to be tinged of the same hue. 'There is nothing more elegant,' says M. Joly, 'than the form of this little crustracean; nothing more graceful than its movements. It swims almost always on its back, and by means of its fins and tail it runs in all directions through the element it inhabits. It may be seen to mount, descend, turn over, spring forward, curve its body into the form of an arch, and then rebound, and deliver itself up to a thousand bizarre and capricious gambols. Their feet are in constant motion, and their undulations have a softness difficult to describe.' . . . 'If we observe, in a small quantity of liquid, the mother at the time of parturition, we see the young group themselves round her body, and there is nothing more pretty, more agile, more graceful than this little troop. But soon the scene changes; one, two, or three young ones are involved in the current which the motion of its fins causes, they pass into the gutter situated between these organs, and from thence come to the mouth of the mother. She at first disperses them as being inconvenient bodies, but soon afterwards they present themselves again, and pressed upon by the stiff hairs which form the branchiæ, then by the papillæ, lastly by the jaws, they arrive at the mandibles reduced nearly to pulp, and they are swallowed as any other substance would be.'" *

Though mostly found, as has been stated, in brine pits, this species also occurs in saltmarshes. The cause of its red colour

* Baird's *Entomostraca,* p. 59.

has been ascertained by M. Joly to depend on its food, which consists to a great extent of a small monad (*Monas Duvallii*) which colours the marshes and reservoirs of Montpellier. Whether the same cause exists in the saltpans at Lymington I do not know, but it is remarkable that the spontaneous vegetation which arises in vessels of stagnant salt water has often a red hue. Thus, Mr. Gosse tells us* that a tank of sea water on one occasion produced in great profusion patches of a "rich crimson-purple colour," which spread rapidly over the bottom and sides of the vessel, as well as over the surface of the water. This proved to be a sea-weed of the genus *Oscillatoria*, apparently undescribed in Dr. Harvey's *Phycologia*. But it seems unnecessary to resort to phenomena of this kind for an explanation of the colour of the *Artemia*. There is a very common tendency to redness amongst Entomostraca, which appears to be quite independent of the colour of their food. I have seen a variety of *Cyclops quadricornis* so red as to appear like brilliant spots amongst the mud in which it was taken; and amongst a gathering from Grisedale Tarn, in Westmoreland, were multitudes of *Diaptomus Castor*, which looked like animated scraps of red sealing-wax. The marine species (*Cetochilus septentrionalis*, &c.) may sometimes on a fine summer day be taken in such abundance as to resemble a mass of red paint in the bottom of the net. The Great Salt Lake of the Mormons is stated to contain twenty per cent. of saline constituents—precisely the strength of the solution which *Artemia* inhabits—and is also said to be quite devoid of animal life. We do not read, however, that it has ever been examined with a view to the discovery of minute forms. Possibly it may contain curious examples of this much-enduring race, for that its waters are not fatal to all phases of animal existence is proved by the multitudes of caddis-cases which are found washed up on its banks.

Bearing in mind the excessive fecundity of Entomostraca, we need feel no surprise at the prodigious shoals in which they are met with. Some of the *Daphniæ* have been observed in numbers large enough to give to the water in which they swam the appearance of blood. Dr. Baird says that he has himself seen "large patches of water assume a ruddy hue, like the red rust of iron, or as if blood had been mixed with it, and ascertained the cause to be an immense number of *D. pulex*. The myriads necessary to produce this effect is really astonishing, and it is extremely interesting to watch their motions. On a sunshiny day, in a large pond, a streak of red, a foot broad, and ten or twelve yards in length, will suddenly appear in a particular spot, and this belt may be seen rapidly changing its

* Gosse's *Romance of Nat. Hist.* 2nd Series, p. 105.

position, and in a very short time wheel completely round the pond. Should the mass come near enough the edge to allow the shadow of the observer to fall upon them, or should a dark cloud suddenly obscure the sun, the whole body immediately disappear, rising to the surface again when they have reached beyond the shadow, or as soon as the cloud has passed over." I on one occasion gathered a curious species, *Cyprideis torosa*, Rupert Jones (fig. 8), in such numbers, that when the contents of the net were turned out into a bottle of water they resembled a huge mass of mites in constant motion. Though naturally unable to swim, they were literally "all alive and kicking; this was in a salt marsh on the Northumberland coast, but it is in the sea that Entomostraca reach their most astonishing development as to numbers. So numerous are they in the South Atlantic, that they form the chief food of the whale; and the red streaks which have been noticed as sometimes occurring in freshwater ponds, may in those regions be seen in the sea on an infinitely larger scale, stretching over many miles of its surface. "They swarmed in myriads," says Vauzème, "and when the wind was boisterous, a whole bank of them would be taken up by a wave, and carried on board the vessel, covering the deck and the clothes of the sailors." On our own coasts they may be seen in scarcely inferior numbers. The Rev. Mr. Norman has noticed them in a sheltered bay among the Shetland Islands, so numerous that the water was literally thick—viscid with them, so that when a net was dipped amongst them, and allowed to drain, quite a consistent mass remained. And Mr. Goodsir says, respecting the Firth of Forth :—"On looking into the water it was found to be quite obscured by the moving masses of Entomostraca, which rendered it impossible to see anything even a few inches below the surface; but if a clear spot is obtained, so as to allow the observer to get a view of the bottom, immense shoals of cod-fish are seen swimming lazily about, and devouring their minute prey in great quantities. Occasionally small shoals of herring are seen pursuing them with greater agility. Great numbers of Cetacea often frequent the neighbourhood in the summer months, droves of dolphins and porpoises swimming about with great activity; and occasionally an immense rorqual may be seen, raising his enormous back at intervals from the water, and is to be observed coursing round and round the island."

As to diet, Entomostraca exhibit by no means a vegetarian tendency; on the contrary, they appear to be in many cases most ferocious in their mode of supplying the commissariat. Doubtless they fulfil a very useful purpose in destroying great quantities of decaying animal matter, and when put into an aquarium which does not afford a sufficient supply of this sort

of food they quickly pine away. But it is not only on *dead* animal food that they subsist; they devour voraciously multitudes of infusorial animalcules, and even, as we have noticed in the *Artemia*, their own young. The *Cyprides* are among the most bloodthirsty of the race. They not only prey upon each other, but upon animals much larger than themselves, such as the *Chirocephalus*.

The free-swimming Entomostraca are mostly very active in their habits, but there is great variety in the character of their motions. *Cyclops* swims through the water with a succession of short, rapid jerks; the *Cyprides* work their bivalve shells along steadily, but rapidly, by means of their lower antennæ acting as a pair of paddles; whilst an allied genus (*Candona*) is unable to swim because these lower antennæ are not armed with the long filaments which give swimming power to *Cypris*. *Candona*, therefore, is content to crawl on the bottom, or on the leaves and stems of water-plants. The beautiful motions of *Chirocephalus* and *Artemia* have already been referred to. The most grotesque and amusing of the whole tribe are the *Daphniæ*; these curious creatures use a pair of long arms or antennæ as propellers, which they work up and down most energetically; and as the machinery comes to an occasional stand-still, they look, with arms raised high above their heads and great staring eye, as if transfixed with stupid astonishment.

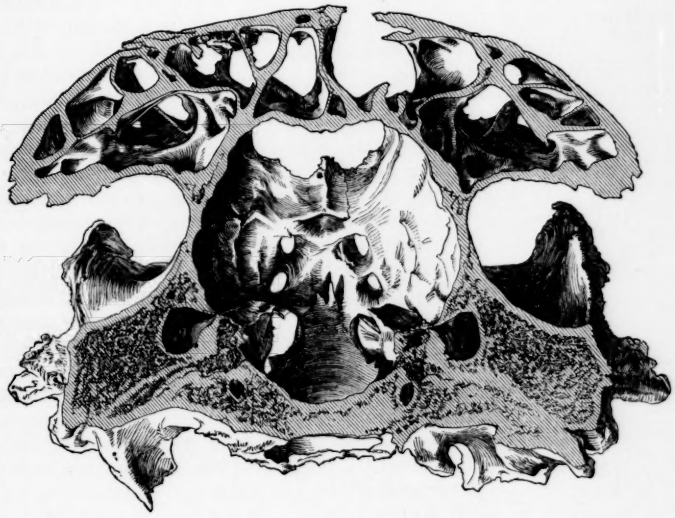
Standing in strange contrast to the liveliness of the *Daphniæ* is the lazy helplessness of a nearly allied form, *Acantholeberis sordida*. This singular species has, within the last few months, been found for the first time in Britain by the Rev. A. M. Norman, whose account of it has not yet been published. It has been taken on the Continent by two naturalists, but they each found only one specimen, nor could they ever succeed in re-discovering it. Their attention was first drawn to the animal by observing it lying motionless—a bright red speck—at the bottom of their collecting bottle. Mr. Norman's experience was precisely similar, but he has been more fortunate as regards the *number* of specimens taken, his captures having amounted to four or five. Still, it is evidently a species of excessive rarity, and not more rare than curious. The creature is built, so to speak, on the model of a Daphnian, for swimming, but its antennæ, which ought to raise and propel it through the water, seem too weak for their purpose; and as no crawling apparatus is provided, it lies on its back, waving its clumsy arms, and reminding one forcibly of the man who, when his cart got into the mire, did nothing but throw up his hands and call to Jupiter for help. The only progression which I have ever seen it make was a sort of jumping, pro-

duced by using one arm like a leaping-pole against the bottom of the vessel. When full grown, it is mostly covered with diatomaceæ and other confervoid growths, so that the continental authors alluded to suppose this to be the reason of its inactivity. Such, however, is not the case, as the following observations will show. A specimen which was sent to me by Mr. Norman to make drawings from, produced, while in my possession, five young ones. These, though they were for a few hours rather more active than their parent, presently took to the same mode of life, and though at first perfectly free from any parasitic growth, they soon became covered with diatoms, etc.—the *result*, not the cause, of their inactivity.

Pertaining to the anatomy and physiology of the Entomostraca, there is much of the highest interest which we have not at all noticed.

There is also a large group of parasitic species, deriving their nourishment chiefly from the juices of fishes and the larger Crustacea, concerning which a very few words must for the present suffice. These curious beings infest both marine and freshwater fishes, mostly attacking such as are in a sickly condition—unless, indeed, the sickliness be a *consequence* of their presence. Fish thus infested are called by the fishermen *lousy*. Some of these species attach themselves by suckers; others possess hooks, or anchors, which they bury in the tissues of their unfortunate victim, obtaining by this means a hold which baffles every effort at dislodgement. No part of the fish's body is secure from the vermin; most of the commoner species live on the skin, fixing themselves in the interstices between the scales; but some forms are found only on the gills and eyes. Fig. 9 is a representation of *Lerneonema Spratta*, a species which has been found attached to the eye of the sprat. Fig. 10 is *Nicothoe Astaci*, whose habitat is the gills of the common lobster.

In conclusion, we may say that scarcely any field of research offers more abundant chances of success in the discovery of new species, or more room for investigation towards solving doubtful physiological problems. There are but few labourers in this field, and whilst the student will find in the monograph of Dr. Baird, published by the Ray Society, and in Mr. White's excellent little *Manual of British Crustacea*, admirable guides to his researches, he will, in all probability, before he has gone very far, prove for himself, by the discovery of undescribed forms, how little labour has as yet been spent over this interesting group of beings.



THE FRONTAL SINUSES OF BOS BUFFALUS.

BY SHIRLEY HIBBERD.

In making a sectional division of a skull of Bos buffalus, the immense development of the frontal sinuses were a matter of surprise, and as but few sections of heads of this and other species of Bos have been published, it was thought advisable to place the section in the hands of the engraver. The subjoined cut is in every detail faithful to the original; and the reader will doubtless agree with the writer, that the frontal bones have a strange conformation. The animal which supplied this skull was full grown and of grand proportions. The horns were remarkably symmetrical, and in every respect conformable to the figure and description of the species in Vasey's monograph of the genus Bos (p. 76). The characteristics of the species are, convex forehead, horns flattened at the base, bent down, and re-curved at the tip. The Arnee is said to be a variety of the species with larger horns, not bent down.

Placing the section aslant at an angle of 45°, with the occipital below, we have presented to view the sawn face of the section, extending through the frontal and temporal bones, just above the plane of the auditory foramina, and within the eighth of an inch of the foramen magnum. The brain-case is

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large and deep anteriorly, the sphenoid considerably depressed, optic foramina small, the structure of the whole dense and heavy, the diploë in some places scarcely distinguishable from the external tables, which are hard as flint. It will be seen by the cut that the frontal forms a huge protecting shield over the brain-case, and that it projects right and left by horn-like processes, and is throughout its whole bulk divided into a series of partitions or sinuses, the walls of which are arranged symmetrically. They are very dense, and the spaces between them vary in form and size, though if a vertical line be drawn through this portion of the skull at the sagittal suture, the sinuses on one side are very exact counterparts of those on the other. From the upper exterior edge of the frontal at the sagittal suture, to the sectional line over the foramen magnum, the measurement is $7\frac{7}{8}$ inches. The extreme width of the frontal, measured from the extreme points of the horn-like projections is $11\frac{1}{2}$ inches. The two lateral sinuses differ slightly in size; that on the left hand in the cut, measures $3\frac{7}{8}$ inches in length, and $1\frac{5}{8}$ inches across at its widest part, by a line drawn across it vertically. The other has a length of $3\frac{5}{8}$ inches, and $1\frac{7}{8}$ inches respectively. The loss of a portion of the intersecting walls of the sinuses to the right of the sagittal suture, was owing to an accident in making the section, owing to the extreme hardness of the bone. The cavity of the cerebrum is, in the opinion of the writer, proportionately large, but this opinion is hazarded in the absence of means of comparison with similar sections. In the section the measurement across at the line of the two wings of the sphenoid is $4\frac{3}{4}$ inches, and vertically, from the central dip of the inferior surface of the frontal to the superior ridge of the temporal, over the foramen magnum, is 5 inches. It was not possible to measure the internal capacity of the brain-case in this instance, the portion of the skull figured being the only one which remained for leisurely examination, and that was kept solely on account of the curious conformation of the sinuses.

No doubt many reasons may be conjectured to account for the peculiar structure of the frontal. It evidently possessed immense strength, both for the support of the horns and for their use as weapons of offence. But it is worthy of remembrance that this buffalo is semi-aquatic in its habits, and thrives best in regions most infected with malaria. May not the sinuses be in some way connected with the function of respiration, to enable the creature to bear submersion for some length of time while fording a stream, or when taking shelter in the swamp from the myriads of insects which annoy it?

JENYNS'S MEMOIR OF HENSLOW.*

THE career of the late Professor Henslow was well worth its memorial in a biographical form. As a man, he possessed an honesty of purpose and force of character which led him, in spite of serious obstacles, to make his own knowledge and powers of observation the means of benefiting all with whom he came in contact. From childhood his tastes were scientific, with special tendencies to botany, entomology, and other branches of natural history. He carried his pursuits with him to Cambridge, and instead of sinking under the dead routine of mere classical and mathematical studies, he was one of the few gifted men who infused a new life into that venerable place, which was thus rescued from being a mere museum of mediæval notions, and brought into something like harmony with the wants and the spirit of a more enlightened age. Let us not depreciate either literature, or pure mathematics; but however permanent may be the value of the masterpieces of Greek and Roman writings, or the importance of studies directed to the consideration of the properties of number and form, it is quite clear that thousands of young men might go through the old form of scholastic training, and be left with very narrow minds, and feeble conceptions of a host of matters of primary importance at the present day. From bygone periods we are mainly distinguished by our advances in positive knowledge, and from the number of directions in which scientific principles are applied to the affairs of life. We recognize the dominion of law—which is nothing more than the continuous, unchanging expression of Divine intelligence and will—in every department which human thought can penetrate, or human action effect, and we endeavour to shape our conduct so as to make the powers and forces of nature the executive ministers of our commands. Wordsworth grandly tells us—

> "Winds blow, and waters roll
> Strength to the brave;"

but the brave must neither be ignorant nor stupid if they wish the elements to serve them. It is knowledge that gives the talisman by which their services are compelled. Simple as this fact is, modern intellectual reformers have had a hard task to enforce its recognition, and though Professor Henslow had predecessors and fellow-labourers in the good work, still to him must be assigned a large portion of the honour of forcing the physical sciences into the educational scheme.

* *Memoir of the Rev. John Stevens Henslow, M.A., F.L.S., F.G.S., F.C.P.S.*, late Rector of Hitcham, and Professor of Botany in the University of Cambridge. By the Rev. Leonard Jenyns, M.A., F.L.S., F.G.S., F.C.P.S. Van Voorst.

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In 1822, Dr. Clark, the Cambridge Professor of Mineralogy, died, having done much by the excellence of his lectures to kindle an ardour for scientific pursuits. Mr. Henslow was his temporary successor, although he had not completed his M.A. degree. In 1825 the chair of Botany became vacant, and it had long been the object of Mr. Henslow's desire. Mr. Jenyns tells us that the previous professor, Martin, was at the time of his decease a very old man, who ceased to lecture, or even reside at, the University. Sir James Edward Smith had indeed offered to supply the deficiency in 1818, but the tutors of the Colleges prevented his delivering lectures, "on the ground of his being neither a member of the University nor a member of the Church of England." "Darkness rather than light from any candle but our own," was the motto of these distinguished pedagogues, and, so far as botany was concerned, they remained in the dark, till fortune sent them a teacher whose qualifications they did not dispute. Except in the hands of a real man of science, botany is apt to degenerate into the mere acquisition of a multitude of hard words. An unfortunate vegetable, or any of its parts, is treated to a nickname with which the pupil does not associate the ghost of an idea; and the mind is no more cultivated by the process than if the memory had been burdened with an equal number of unexplained terms from the extinct dialects of the Caribbean Sea. This vain pretence of learning did not satisfy Mr. Henslow, who provided his pupils with baskets filled with living plants, which he taught them to dissect, and thus follow his expositions of their structure and modes of growth. In the same spirit he made the botanical examinations of the London University realities—not shams—in which the real knowledge of the student could be tested, and positive acquisition preferred to useless cram. Part of his system, as a teacher, consisted in excursions to various districts, which were attended by entomologists and others, as well as by botanists—all being glad to avail themselves of the Professor's extensive information, and his readiness to help all who were in need.

After being allowed to labour for many years in honourable poverty, he was fortunate enough to obtain the living of Hitcham, in Suffolk, worth more than £1000 a-year. Whether an honest change to liberal opinions, and service to the Whigs, induced Lord Melbourne to give him this preferment in 1837 does not very clearly appear, but it opened for his energies a new sphere of exertion, in which he laboured with great zeal and success, continuing to perform the duties of his professorship all the while. He found his new flock in a deplorable state, but not worse than many agricultural districts were at that time, and perhaps not worse than some still remain. A straggling street

held about a thousand persons, amongst whom was a sad proportion of vagabonds and unemployed. The real property was assessed at £6000 a-year, but the village had no better educational apparatus than a single dame school. Ignorance, crime, beggary, vice, and destitution had possession of the charming place, and supplied enough dragons for the knight of science to assail. Hitcham might have had a new rector of equal benevolence, but less knowledge, and then in spite of well-meaning exhortations, the dragons would have won the day. Not so with Professor Henslow. He studied the characters he had to reform. Cricket, and other manly games which rose under his auspices, prepared their minds as well as their bodies for healthy admonitions of a moral kind, while an annual exhibition of fireworks on the parsonage lawn attracted many to look at specimens of natural or artificial curiosities which no one knew better how to explain.

He lost no time in establishing a better school, and he instituted ploughing matches, and promoted allotments, to raise the labourer in the social scale. The farmers raised an outcry against this latter innovation. "They held their men," says Mr. Jenyns, "in grievous subjection. They viewed them as little better than slaves to do their work." It was a terrible task to teach these thick-headed farmers that their own interests would be served by doing their duty to the labourers. So high did their antagonism rage, and so fully were they imbued with the kind of feeling that actuated the Cambridge tutors in their opposition to Sir J. E. Smith, that they actually passed a resolution to "refuse all employment, and show no favour to any day labourer who should hold an allotment." Nothing daunted by these threats, Professor Henslow circulated a printed statement of his unalterable determination to sustain the rights of the poor, and so the allotments flourished, and the ignorant prejudice was in time put down.

Another benevolent scheme, in which Science taught Benevolence what to do, was the establisment of Horticultural Shows, in which prizes were given for things such as wood-carving not specially connected with the object indicated in the name. At these meetings the Professor had his "Marquee Museum," in which he delivered what he called "lecturets" to all who chose to come. The objects exhibited were selected to suit all tastes, even the children had their case containing a "heap of shells and corals," and a "new device from the last horticultural show in Fairy Land." Among the prizes distributed on these occasions were some to the village botanists—botany being a subject of instruction in his village school. On Monday he spent one or two hours in this pursuit, "the botanical pupils were all volunteers, and limited in number to forty-two.

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They varied in age from eight to eighteen, and mostly entered with great spirit into the work set before them, seeming thoroughly to enjoy it." In dealing with his uneducated students, the Professor displayed uncommon tact. So far as practicable, the difficulties were diminished, but those inherent to the subject were as fairly met and as fully conquered as if the village children had been members of his university class. As technical terms could not be dispensed with, the boys and girls who wished to learn botany, had to begin with spelling dicotyledons, monocotyledons, angiospermous, and other afflicting looking words, which in due course were practically explained. Deal stands furnished with vials afforded the means of displaying the wild flowers that could be obtained in blossom, and which the children were encouraged to collect, in order that they might be properly labelled and form the subjects of the lesson to be conveyed. Each pupil was supplied with a dissecting board "made of deal, twelve inches long and nine wide. Across the upper half of each board was pasted a paper with four compartments. Opposite these, the names of the four floral whorls, and their subordinate parts, were printed, together with the adjective terminations for expressing botanically the numerical and other relations between them."

The children pulled their flowers to pieces, and wrote the results of their examinations upon their slates, which were all sent to the rectory to be looked over and corrected. For further details of this admirable method of teaching, we must refer to Mr. Jenyns's work, but we must not forget to allude to the annual excursions, in which he conducted his pupils to some pleasant place, and to the larger excursions in which the adult villagers joined. In one instance he conducted a large party to Ipswich, where they saw the town and the Museum which he arranged. Another time they went to Harwich, and many had there their first sight of the sea. In other years Norwich, Cambridge, and Felixstowe received the happy parties, the funds for their trip being provided partly by the Professor, who thus appropriated the sum that his predecessor expended upon a tithe dinner, partly by other donations, and partly by the subscriptions of the people themselves. Such continued goodness, guided by intelligence, converted even the farmers, and in testimony of their estimation they presented their rector with a silver cup.

Such a man was Professor Henslow, as a teacher of science, and a social reformer, of a type which had no existence in prescientific days. We have regarded him under two aspects only, and passing over his claims to honour as an original investigator, or in his purely clerical capacity—subjects which would exceed our limits—we find the spirit of knowledge strong in

death at the close of his career; for as disease was busy changing his mortal state, he studied the phenomena of a dissolution, of which his religious nature had no fear.

His greatest works remain behind in the moral and intellectual elevation of his pupils, his parishioners and his friends; but his writings were numerous, not the least important being the elementary, such as the "Practical Lessons in Botany," compiled for the South Kensington Museum, and his admirable "Dictionary of Botanical Terms,"* which is an invaluable aid to the regular student, and a work of constant usefulness in family circles where scientific tastes prevail. In this excellent little volume each word is clearly explained, and its derivation given, while numerous woodcuts convey at once to the eye the information which words alone might fail to give.

BALBIANI ON THE REPRODUCTION OF INFUSORIA.†

Our present object in dealing with M. Balbiani's researches is expository, not critical, so for the sake of brevity we omit historical details and pass at once to his declaration that "Infusoria, like other animals, propagate at certain epochs with the aid of elements characterizing sexual generation." These elements originate in the interior of organs known as the *nucleus* and *nucleolus*. The nucleus is the producer of germs or ovules, the nucleolus develops fecundating corpuscules, or zoosperms. The first may be considered as the ovary, the second as the testicle of infusoria. These two organs constitute all the sexual apparatus of these animals. In some cases an excretory channel seems added to the ovary, and perhaps also to the testicle, and appears to open directly outside. The reproductive organs are always distinct, though united in one individual; but the hermaphrodism which results from this arrangement is not complete, as the concurrence of two individuals is always needful for the process of fecundation, which takes place inside the creatures, and requires the transport of the male elements of one to the female organs of the other.

The situation of these organs varies considerably, not only in different groups, but also in different species of the same

* *A Dictionary of Botanical Terms*, by the Rev. J. S. Henslow, M.A., Professor of Botany in the University of Cambridge, new edition, illustrated by nearly Two Hundred Cuts. Groombridge and Sons.

† *Recherches sur les Phénomènes Sexuels des Infusoires*, par le Docteur G. Balbiani. Victor Masson, Paris, 1861.

genera. The nucleus, or female organ, exhibits three principal varieties: (1) spherical, or ovoid; (2) tubular; (3) moniliform, or like a chaplet of beads. The nucleolus is much smaller than the nucleus. "The male and female corpuscules are often united simply by their common envelop; but in other cases, not less numerous, the first is received in a depression (*échancrure*), more or less deep, of the second, where it sometimes disappears entirely, but nevertheless preserves its own envelop, although the confusion of the two bodies may be so complete, that the hiding-place of the male corpuscule can only be discovered by the employment of re-agents, such as diluted acetic acid, which determines the condensation of their substance and the visible separation of their walls." M. Balbiani divides Infusoria into (1) "species whose ovary has the form of a little utricle, or bag, of a rounded or ovoid form, containing an undivided mass of vitelline matter. In these the testicle during its existence exhibits a similar appearance." Among these he places Colpods, Glaucomas, Paramecia, some of the Trachelia, Nassula, Chilodons, etc. "In these species the ovary has constantly the form of a little vesicle, usually situated in the middle of the body, and completely filled with a granular matter, in the interior of which the ovules are developed at the time of sexual reproduction." (2.) "Species with an elongated ovary, cylindrical, or tubular, variously curved or twisted, containing a vitelline mass not presenting divisions (*non fragmenté*). Testicle as in the former." To this division Euplotes, Aspidiscus, most of the Vorticellids, Trachelius ovum, etc. belong. In it "the male organ does not participate in the elongated or cylindrical shape of the nucleus," but in the instances in which M. Balbiani has detected it, appears as "a little globular or oblong corpuscule, free, or more or less entangled (*engagé*) with the substance of the ovary." (3.) "Species with an elongated ovary, straight or bent, containing a vitelline mass divided into two or more distinct fragments (ovary bi or multilocular). Testicle usually composed of an equal number of elements which accompany the vitelline fragments, more rarely of a single element." M. Balbiani remarks, "In the preceding group we have seen the ovary affect the form of a tube more or less elongated, in the interior of which a granular mass extends without interruption from one extremity to the other of the organ. If, instead of supposing this mass equally distributed through the ovarian tube, we conceive it divided into a certain number of fragments which succeed each other with regularity, and in the intervals we imagine the tube more or less constricted, we shall have an exact picture of the arrangement that we shall meet with in all the species composing this group. The family of the Oxytrichians, reduced to its principal

Ehrenbergian types, *Oxytricha*, *Stylonichia*, *Kerona*, and *Urostyla*, exhibits this arrangement in its greatest simplicity." In this division of his subject M. Balbiani describes what is commonly considered to be the mouth of *Trachelius ovum* as a generative aperture.

M. Balbiani considers that species have been erroneously made on account of the appearance presented by the ovary at different epochs. He says, "Since my observations on the singular transformations which the ovary of the infusoria undergoes during the spontaneous division of those animals, it is evident that one phase of these transformations is characterized by the elongated ribbon-like aspect which this gland assumes, shortly before it divides itself between the two new individuals. In this respect the ovoid and moniliform nuclei behave in precisely the same way, and recall for the moment, under this aspect, the form which this gland presents among the vorticellids and other types previously mentioned. These modifications, transitory and purely physiological, have more than once been taken by classifying authors for permanent forms, and employed under this idea for the characterization of certain species. It is thus that under the name of *Stentor Rœselii*, Ehrenberg describes an animalcule which differs from all others of the same genus by its *testicle* (ovary) which takes the shape of a long sinuous band destitute of articulation, while amongst the other stentors it is usually disposed as a chaplet. To this peculiarity we must reduce the difference which Ehrenberg establishes between this species and *S. Müllerí*. . . . . It is only necessary to look at his four figures of S. Rœselii to be satisfied that two of them refer to specimens observed at the moment of spontaneous division. As to the others it is probable that they also relate to individuals about to divide themselves, but in whom the signs of this process, and especially the existence of a longitudinal ciliary crest, which is the first indication of it, had escaped the celebrated microscopist."

Let us now pass to the mode of fecundation, under which title we read, "The facts by which I was led to study the phenomena of the propagation of these animalcules, have received from all the naturalists and physiologists of our epoch, a signification entirely different from that which I assign to them. All these authors in fact see only a longitudinal self-division in the appearance which I shall demonstrate to arise from the sexual union of two individuals, and admit in consequence that the greater part of the species of this class are able to multiply indifferently by transverse or longitudinal fission. The favour with which this opinion—so little conformable to the real state of things—has been received, and generally accepted as one of the best ascertained facts of science, has induced me to describe

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in detail the phenomena of infusorial reproduction. To restore to them their true significance it is enough that I should show, by reference to pure and simple facts, that the infusoria couple for the purposes of fecundation like most other animals. . . . . We have seen that hermaphrodism is the rule among Infusoria . . . . and in mode of fecundation they approach certain gasteropods and worms, which, having both sexes united in a single animal, nevertheless require the co-operation of a second individual to produce fertile germs;" but while these latter are usually provided with well-developed organs for the intromission of the prolific fluid, "the infusoria are totally destitute of them," and to supply their absence, nature has recourse to other means. Describing these, M. Balbiani divides Infusoria into two classes—one having the mouth situated at one anterior extremity of the body, and in the direction of its longitudinal axis, and in others, which form the great majority, this orifice is placed beyond the axis, on one side of the body, and usually in its anterior half; and he speaks of the animals coupling by bringing together the "depressed region placed in front of the mouth; or where it only exists in the form of a minute and simple depression, or narrow groove, by the contact of this part only, the remainder of the body being free. "The exudation of a glutinous substance at the point of contact serves to consolidate their adhesion, by soldering them intimately together; so that their premature separation becomes impossible, notwithstanding the energetic strains to which they expose each other." At first he considered the mouth was the organ for the transmission of the fertilizing fluid, and this opinion was strengthened by noticing its position during the process, but by examining the *Paramecium aurelia* with a good illumination, and powers of 700 or 800 diameters, and treating the objects with very dilute acetic acid, or aqueous solution of iodine, he states he was "able to demonstrate that not only the ovary, but also the testicle, was provided with an excretory duct, whose course he could follow, from its origin in the glands to a point situated below the mouth, towards the posterior extremity of the buccal furrow." The annexed sketch (fig. 1) from M. Balbiani represents the appearance of two Paramecia aurelia slightly compressed, and acted upon by dilute acetic acid: *a* is the ovary; *c* its excretory duct; *b* the

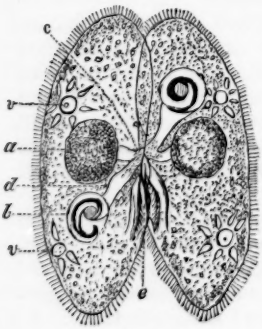

FIG. 1.

male capsule, containing a bundle of spermatozoa bent into an arc; *e* the mouth; *v* the contractile vesicles. M. Balbiani has not been able to ascertain whether the ducts of the two organs unite in one cloaca, or have distinct orifices. In some genera he has not even satisfied himself of the existence of a genital orifice. The coupling lasts from twenty-four hours to five or six days, according to the development of the organs. When they exist only as a simple rounded granule, which is their lowest condition, the longest time is required, and it diminishes as their evolution is advanced. "This remark applies not only to species in which the ovary and testicle are developed simultaneously and attain the end of their transformations at the same time, but also to those in which the evolution takes place in an unequal and successive manner. Constantly the female organ precedes the male organ, in order both of appearance and development, so that in some species (Stentors, Spirostomes) the ovary contains a number of eggs almost fully developed, while no vestige exists of the male elements."

M. Balbiani describes the nucleus as always present, but varying in appearance according to its development. In young animalcules it is a colourless, transparent, minute roundish mass, the contents of which appear granulated when acted upon by acetic acid. "Among most infusoria, the male and female organs disappear completely after each effort of propagation, and are immediately replaced by other productions of the same nature, which, commencing their existence in a rudimentary form, rapidly pass through the phases of their evolution, and re-establish a complete sexual apparatus in a short time. From their first appearance the new organs are of larger dimensions than in young individuals, and thus offer a greater resistance to the action of re-agents, and enable their structure to be better appreciated. If we examine a Stylonichia, Oxytricha, Stentor, or other animalcule possessing this property, immediately after reproduction has taken place, we do not find the nucleus under the characteristic form belonging to the species, but in its stead we note a body which offers the greatest resemblance to the nucleus which the same infusoria presents in a young stage." In some species, M. Balbiani tells us, that the "primitive female ovule" enlarges, and reaches maturity without multiplying itself, except that it divides when spontaneous fission of the animal occurs; in most kinds, however, the primitive egg gives rise to a number of other eggs by transverse division. He observes: "The number of eggs which enter into the composition of the same chain, is often considerable. I have often counted from twenty-five to thirty in certain large Trachelians (*Amphileptus cygnus*, *Loxophyllum meleagris*), and from forty to fifty in adult specimens of *Spriostomum ambiguum*, imme-

diately after reproduction. At other times they are so numerous that their chain can only lodge in the interior of the body on condition of folding several times on itself, as occurs in certain Urostyla." In another place the writer informs us, "When the eggs have reached their full development they exhibit the appearance of little spheres whose bulk is noticeably uniform in the same individual. But at this epoch their transparency is so great, that they only appear in the greater number of species as simple spots surrounded by darker granulations of the parenchyma. It is therefore indispensable, in order to form an idea of their shape and structure, to treat them with a reagent like acetic acid, which augments their cohesion and refractive power. The action of this agent immediately exhibits little globules of a bluish or yellowish-grey, and endowed with considerable powers of refraction. The vitellus, of a homogeneous, or finely granulated appearance, is seen, on being crushed, to be composed of larger or smaller granules loosely adherent, and connected by a mass composed of fine molecular granulations. The germinating vesicle is usually completely masked by the vitelline granulations, and cannot be seen. Sometimes, however, it can be shown by employing first a very dilute solution of caustic potash, and then a little iodine in water, or acetic acid. For the same purpose ammonia and carmine may be employed, which gives the vitellus a rose tint, and causes the vesicle to appear as a more clear central spot."

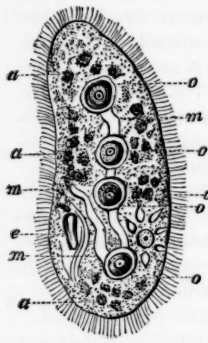

Fig. 2.

Fig. 3.

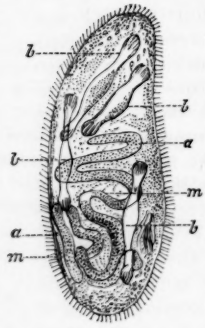

Fig 4.

Although the eggs appear free in the cavity of the body, M. Balbiani affirms that they are enclosed in a membranous canal, which is only the terminal portion of the long, bent, tube resulting from the metamorphosis of the ovary. His view is exhibited in the annexed drawing (fig. 2), taken from his published work, in which *o*, *o*, *o*, *o*, represent the eggs, *m*, *m*, their tube open in *m'* in the buccla groove, *a*, *a*, are sterile fragments of granular matter, and no trace remains of the spermatic capsules; those not having been employed in fecundation being absorbed. In fig. 3 the

male capsule is seen fully developed; the fine lines representing the spermatozoa. In fig. 4 several of them are seen elongated, and ready to multiply by division (*b*, *b*, *b*); the *o*'s again represent fertile ovules in their duct, the *a*'s and *m*'s the ovarian tube, the latter letters indicating empty spaces.

Mr. Balbiani's experiments and observations will no doubt be repeated by other observers, and while recognizing their importance, we must await their confirmation or confutation.

AUSTRALIAN NATURALISTS.

From the *Melbourne Argus*, February 28, we extract the following particulars concerning the Australian "Sea Horses." The specimen alluded to was obtained by Mr. Joseph Harrison, who received it with a statement that it was found on the beach at Lacepede Bay. This same naturalist has formed an extensive collection of Australian entomology, which is said to be particularly rich in beetles, and to contain about seven hundred moths, varying in size from five inches across the wings to the minute dimensions of a mosquito. The colours are described as being very fine. The *Argus* says:—

"A very fine and perfect specimen of the sea-horse—*Hippocampus* (?)—(the Australian species not being yet defined) has been sent to our office by Mr. Joseph Harrison. The most interesting peculiarity in the order to which the sea-horse belongs is that of the males of most species carrying the eggs about them till they are hatched. In some, the egg-pouches are on the breast, in others, on the tail, or the eggs are merely glued on in rows, and not covered by a membrane. In this they seem to resemble the marsupials of Australia, upon the coast of which continent they are common, as well as in the seas which divide it from New Guinea. Notwithstanding the odd and stiff appearance of the sea-horse, and other small members of the order *Lophobranchii*, some have prehensile tails, like those of the American monkey; and when kept in vases furnished with slender twigs to which they can suspend themselves, they form pleasing objects of study. It is said that they resemble the chameleon, in being able to direct one eye backwards and the other forwards. This, however, is not an established fact, though their eyes are certainly movable either backwards or forwards, even if not separately so. We believe that small specimens of this singular fish are pretty frequently found on the coast at Brighton and Glenelg; but the southern species are at present only partially known, and have not, as we remark above, been properly classified."

The naturalization of English and other foreign creatures is making considerable progress, and there is a project on foot

for renting "Betsy's Island" from Lady Franklin's agent, in order to convert it into a nursery for game. Efforts have also been made, but as yet without success, to introduce the *Guramie* from the Mauritius, where it has the reputation of being the best pond fish in the world. Captain Lowrie, addressing the president of the Acclimatization Society, said that he obtained about 300 of these fish, most of them being very young, but about fifty from three to eight inches long. These specimens were divided between an aquarium, furnished by Mr. Jones of the *Argus*, and a seasoned water-cask, hung upon gimbals, each in a skylight. During the first days (the ship sailed on the 19th of January) a good many of the small fry died in the aquarium, but none in the cask. Having provided abundance of fresh water, about five gallons a day were removed from the cask and replaced, and the fish were supplied with a little bran, which the captain says they eat. After getting to sea, those in the aquarium died quickly, while the inhabitants of the cask continued well. Every five days the whole of the water was changed, and air was pumped into the water every hour. On the eleventh day a S.W. gale arose, and the temperature fell to 60°. In the morning all those in the aquarium were dead, except about half a dozen of the largest, which were removed to the cask, whose inhabitants had not been diminished to the extent of five per cent. On the 18th and 19th of February another S.W. gale came, and lowered the temperature to 57°, and by the morning all the finny passengers had perished. Captain Lowrie thinks that on another voyage he may manage to transport the Guramies safely, if he employs a stove to prevent the temperature falling below 70°, but if they should arrive safely in Australia, it is by no means clear that they would thrive in any but the warmest spots.

THE DOMESTICATION OF SCIENCE.

A COUNTRY may contain a considerable amount of scientific knowledge, and may take a high stand for the variety and originality of its investigations, and yet the majority of its homes may remain in a comparatively ignorant state. The university may have its learned professors, the schools of medicine may possess able demonstrators and lecturers; and yet the general condition of society may be feebly affected by the elevating influence of scientific tastes. While this is the case, science cannot be said to be domesticated. It may manifest its power in great national undertakings, in the improvement of particular branches of manufacture, or in arrangements for the public health; but it contributes nothing to the intellectual or moral dignity of the homes of the people. Such was the state of England until a very recent date; and although we have now emerged from the profound barbarism of the Georgian era, we are only at the very commencement and threshold of those beneficent changes by which social relations will be modified and improved. Compared with other countries in Europe, or in America, we may have a large number of persons capable of appreciating scientific reasoning, or engaged in some kind of scientific pursuit; but many families in the middle and upper classes are still deplorably ignorant of elementary laws and facts; and vanity and frivolity too often rule their leisure hours, because they are not sufficiently cultivated to appreciate the delights which any form of study can afford. In ordinary schools the physical sciences are as much neglected as if Nature offered no phenomena to investigate, no principles to discern; and although so-called "mechanics'" and other institutions are scattered by hundreds over the land, the lecture system has been degraded into a mere amusement for idleness; and the subjects selected, succeed each other in defiance of any method by which positive knowledge can be increased. On the other hand, we may note with satisfaction the rise of naturalists' field clubs, and other societies by whose agency a large amount of information is pleasantly obtained, and likewise the extensive sale of numerous publications of a more or less elementary kind. There is also the striking fact of the great increase in the number of purchasers of microscopes and telescopes, which are becoming necessary portions of the furniture of every well-ordered home.

In London and many other great towns, the means are now provided by which systematic study may be carried on at a moderate cost; and thousands of young men destined for industrial pursuits are preparing for their future career by laying a

foundation of natural philosophy, chemistry, and geology, and other researches of a scientific kind; nevertheless, it too often happens that the scientific member of a family is an isolated being. He, or she, may be applied to as a convenient dictionary to explain any hard word that occurs in casual reading, or to elucidate any startling fact that forces itself upon the attention, but his pursuits are not contagious, and his tastes seldom elevate the household to which he is attached. Where the microscope is habitually used, the beneficial influence of a good example is more easily felt, as few can resist the opportunity of viewing the exquisite objects which a skilful manipulator can so readily display. But in this as in other occupations, the presence of unsympathetic persons is disagreeable, and families can gain little from a microscopic member unless they make him sufficiently comfortable in the general circle to draw him from his special retreat. Similar remarks may be made with reference to telescopic inquiries. Most people are delighted to see the sun rise and set upon the jagged peaks of the crescent moon, or behold on the full face of our satellite the appearance of seas,* continents, and volcanic cones. In both cases, however, the interest is evanescent, unless the mind is prepared by previous knowledge to speculate upon the objects presented to the view. Where there is no idea of the relation between life and organization, no conception of physiology, natural history, or biology, the microscope is no better than a toy, from which only temporary amusement can be obtained; nor can the telescope minister to a more permanent delight, if some previous study does not indicate the meaning of lunar formations, or tell the story of the planet or the star. In all the aspects of Nature those see most who know most, and unless the faculty of attention is cultivated, the difficulties which beset the porch of science cannot be removed.

The existence of our own magazine, and the wide welcome it has received in every town, may be taken as a convincing proof that intellectual tastes already possess an extended sway. Twenty years ago, no sane publisher would have ventured on such an experiment, and many who expressed their personal delight at our proceedings, thought we made a great mistake in offering matter of so high a class at so low a price. For the select few, they knew strong meat would be required, but they doubted the existence of many who could digest anything better than the milk-and-water that is deemed suitable for babes. We knew more of British society than our faint-hearted friends; we did not expect to circulate with the velocity of the penny novel or the startling romance; but we did

* Most of our readers are aware that the moon is supposed to be destitute of water, and that her seas are dry.

not forget the adage that "many a little makes a mickle;" and although in any given street or town, the cultivators of science are an undoubted minority, yet when all are put together they make a mighty host. We aimed at the homes of the intellectual, and there we are.

During the past six months we have had a swarm of correspondents; and although the extent of our constituency rendered it impossible that we could reply to individual communications, we have not lost sight of any useful hint; and although we have not repeated our programme in so many words, we have not forgotten to provide our readers with something to do, while we have endeavoured to lay before them abundant matter about which they might pleasantly and profitably think. From our own observations during many years, and from portions of our correspondence, we have discerned in many individuals and families a want of self-help. In reference to popular astronomy, people deficient in this quality are apt to forget how easy it is to learn from an almanac—like Dietrichsen and Hannay's—a host of necessary facts about the rising, southing, and setting of the sun, moon, planets, and stars. In chemistry they forget the number of cheap manuals which they can easily use, but which we cannot undertake to reprint. In microscopy they do not perceive that every atom they come into contact with is an object that they may examine, and that every description of minute anatomy, or organization, supplies hints concerning what they are to observe. Persons whose tastes are decided, and mental fibres firm, may do wonders by themselves, but co-operation, invaluable to all, is indispensable to most. The members of a good local society can see what others do, and how they do it. They can refer to one colleague for the name of a plant, to another for the description of a fossil, to a third how to get over a difficulty in using an instrument of research. In many circles this kind of mutual help takes place without formal arrangements for its provision. Families fond of any branch of science naturally associate together—and how far preferable is a gathering for any rational purpose, to a conglomeration of tedious mortals bent upon a millinery and tailorcraft display.

The domestication of science and literature—which are the closest allies—is a most important incident for civilization and happiness; and although the male part of creation may do their share of the good work, it cannot be accomplished unless the women choose to aid. The very general failure of mechanics' and similar institutions to provide the means for scientific culture, has naturally arisen from the average condition of the families from whom their members were derived. Even in the metropolis—if we except the feeble efforts of the London Institution, which al-

though rich in funds, has sunk into a state of intellectual paralysis —it is in Albemarle Street only, that any association of the kind does really serviceable work; and even there the pay of the professors does not equal that of a first-class bookkeeper, or an attorney's managing clerk. In 1801 Davy was secured for a hundred guineas a year, "one room, coals, and candles." Faraday began with twenty-five shillings a week, and it was only in 1853 that his remuneration reached the annual value of £300. Tyndall was captured in 1853 for the small sum of £200, and in 1859 his income was raised to £300. We mention these facts as specimens of the difficulties which still beset the pursuit of science, for although considerable incomes may now be gained in some departments, original research, and the best kind of popular exposition are as unremunerative as of old. What we want for the domestication of science is, that each town and district should regularly supply two courses of instruction, the one elementary, and the other intended to keep pace with the advancing knowledge of the day. But whether the means of study be public or private, a logical system should be pursued. Thousands of intelligently disposed people find every scientific subject difficult, because they have never mastered the elements of a single one. If the principle of the lever, the nature of fluid pressure and motion, the simplest incidents of electric repulsion, attraction, or induction, the chemical phenomena of combustion and combination are not understood, no progress can be made. Such matters ought to be taught alike to boys and girls in school, and easily secure their attention if illustrated by appropriate experiments. We say these things *ought* to be taught in the scholastic routine; but as the great majority of the pupils of expensive establishments learn no more of them than if they had been placed under chloroform as soon as the term commenced, and only revived for the holidays, the neglect of the pedagogues must be repaired after their inefficient labours have been performed.

In 1810 Sir Humphry Davy appealed to the "higher female classes" in words which are now applicable to women of all ranks. He said, "Let them make it disgraceful for men to be ignorant, and ignorance will perish; and that part of their empire founded upon mental improvement will be strengthened and exalted by time, will be untouched by age, will be immortal in its youth." Unhappily, we have still a number of uncultivated young men who do not feel at ease in the society of intelligent women; and mothers of a certain order look upon their girls as a kind of live stock, to be grown so as to suit the taste of the market, whatever it may be. Notwithstanding these circumstances, the demand for stupidity, whether male or female, is less than it was; and both sexes

are beginning to perceive that, where ignorance rubs against ignorance, dulness is the result. Domestic life without ideas is worse than a bottle with no wine in it. When the actual business of the day is transacted, ignorant people have nothing to interchange, and they suffer the disadvantage of solitary confinement in a crowd of the same sort. Quarrelling, under such circumstances, is Nature's effort to break a monotony which their constitution cannot endure. The happy home is the intelligent one, where each member communicates something to the common stock of thought and knowledge, and where the family does not consist of an ill-assorted aggregation of babies great and small, dependent for their amusement upon some rattle of frivolity, or the chance of a stranger tickling them with a fashionable straw. Of such happy homes there are thousands in our country, and we say of their possessors, "May their tribe increase." To them the capture of an insect, the opening of a flower, the skimming of a pond, or the movements of a star, furnishes occupation and delight. Nor are human interests forgotten, because all Nature speaks with a million voices, proclaiming truths which the ignorant do not hear. As a rule, the most cultivated families are the most efficient workers in every useful direction. They may not choose to go out of doors for purposes of no worth; but, by making all with whom they come into contact wiser, they augment the forces which are employed in removing evil, and add to the powers which labour effectively for good.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

CHEMICAL SOCIETY.—*May* 29.

Action of Mordants in Dyeing.—On May 29th, several interesting papers were read. An elaborate memoir by Mr. W. Crum, "On the Action of Mordants in Dyeing," explained, with much detail, the nature of the union between fabric and dyeing materials. Mr. Crum repudiated the idea that any chemical union took place, but regarded the action in some cases as one of adhesion to an extended surface, in others where the colouring matter (or mordant and colouring matter) is in solution, absorption took place. The structure of the fibre bears out this view, for on examining cotton under the microscope it is seen to be composed of flattened tubes with translucent walls, permeable, no doubt, to fluids. When mordants are used they are often deposited within the fibre, and

retained there mechanically, and afterwards, combining with the dye, serve to fix it in the material. What is technically termed *dead cotton* does not take the dye, for being immature or imperfectly formed fibre, it possesses no central tube; it occurs in small quantities along with ordinary cotton, and remains white and unaffected after mordanting and dyeing. Mr. Crum exhibited numerous specimens of dyed and printed cotton fabrics in which threads and bundles of undyed dead fibres were very well seen.

On the same evening Mr. Riley read a paper in which he announced the presence of titanic acid in a number of specimens of clay which he had tested for that substance; he believed that it was an invariable constituent of clay. He found also, that in all cases in which the blast furnaces produced good iron, titanium was present. This result is in accordance with the conclusions of several chemists and manufacturers, who have pursued experiments in the same direction.

CHEMICAL SOCIETY.—*June* 5.

Oxide of Ethylene: a Link between Organic and Inorganic Compounds.—The recent meetings of the Chemical Society have been peculiarly interesting, MM. H. St. Claire-Deville and A. Wurtz having delivered two instructive and eloquent discourses to a large concourse of its foreign and English members.

The first-named of these illustrious French chemists gave an account of the laws of Vapour-Densities, detailing more especially the chief results of those experiments of his own which tend to throw light upon certain apparent perturbations of these laws; the lecturer's comparison of such perturbations to analogous phenomena in astronomy and other sciences was most happily conceived and clearly enounced.

Professor Wurtz's discourse on "Oxide of Ethylene, considered as a Link between Mineral and Organic Chemistry," was given on June the 5th. It is to M. Wurtz that we are indebted for the discovery of many of the most important facts in the history of that well-known hydrocarbon, ethylene, or olefiant gas. The first glimpse into the true character of this interesting product was obtained by Herr H. L. Buff in 1855, but in the following year M. Wurtz obtained from it several new derivatives, one of these, more especially remarkable, having given him the means of procuring the substance which formed the topic of his discourse.

The gaseous hydrocarbon ethylene, represented in chemical symbols by the formula C_4H_4, has been long known to combine with two equivalents of chlorine, forming a heavy oily liquid, $C_4H_4Cl_2$, termed Dutch Liquid, or Oil of the Dutch chemists. Now these expressions suggest nothing as to the constitution of this product, but many views have been held with regard to it; some chemists, for instance, believing it to be a compound of hydrochloric acid and chloride of vinyle (C_4H_3Cl), because, when

acted upon by caustic potash, hydrochloric acid was removed from it, in this way :—

$$\underset{\text{Dutch Liquid.}}{C_4H_4Cl_2} = \underset{\text{Hydrochloric Acid.}}{HCl} + \underset{\text{Chloride of Vinyle.}}{C_4H_3Cl.}$$

A simpler view regards it as a bichloride, presenting some analogy with the inorganic chlorides, such as that of platinum :—

$$\underset{\text{Bichloride of Ethylene.}}{(C_4H_4)Cl_2.} \qquad \underset{\text{Bichloride of Platinum.}}{PtCl_2}$$

On heating bichloride of ethylene with acetate of silver the following change takes place :—One equivalent of the former substance, containing two equivalents of chlorine, removes, from two equivalents of acetate of silver, two equivalents of silver in the form of chloride, while the remainder of the constituents of the two bodies unite to form acetate of ethylene. The chemical equation representing this change may be put thus :—

$$\underset{\substack{\text{Bichloride of}\\\text{Ethylene.}}}{C_4H_4,Cl_2} + \underset{\substack{\text{Acetate of}\\\text{Silver.}}}{2AgC_4H_3O_4} = \underset{\substack{\text{Chloride of}\\\text{Silver.}}}{2AgCl} + \underset{\substack{\text{Binacetate of}\\\text{Ethylene.}}}{C_4H_4,2C_4H_3O_4}$$

Or thus :—

$$C_4H_4,A_2 + \left.\begin{matrix}C_4H_3O_2\\Ag_2\\C_4H_3O_2\end{matrix}\right\}O_4 = Ag_2A_2 + \left.\begin{matrix}C_4H_3O_2\\(C_4H_4)''\\C_4H_3O_2\end{matrix}\right\}O_4$$

The two dashes placed after the symbol for ethylene, show that it is equal to two equivalents of silver, Ag_2.

On exposing binacetate of ethylene to caustic potash, acetic acid is removed, and hydrate of ethylene formed. Hydrate of ethylene is also termed glycol, and is an alcohol, standing in the same relation to ethylene as ordinary alcohol does to ethyle :—

$$\underset{\text{Ethyle.}}{\left.\begin{matrix}(C_4H_5)'\\(C_4H_5)'\end{matrix}\right\}} \quad \underset{\text{Alcohol.}}{\left.\begin{matrix}(C_4H_5)'\\H\end{matrix}\right\}O_2} \qquad \underset{\text{Ethylene.}}{(C_4H_4)''} \quad \underset{\text{Glycol.}}{\left.\begin{matrix}(C_4H^4)''\\H_2\end{matrix}\right\}O_4}$$

When glycol, C_4H_4, H_2O_4, or C_4H_4, O_2, H_2O_2, is exposed to the action of hydrochloric acid, a substance intermediate in composition between Dutch liquid and glycol is formed, namely, C_4H_4, O_2, HCl, which, when decomposed by caustic potash, yields oxide of ethylene, C_4H_4, O_2. This is the ether of the series, and stands in the same relation to ethylene as ordinary ether does to ethyle :—

$$\underset{\text{Ethyle.}}{\left.\begin{matrix}(C_4H_5)'\\(C_4H_5)'\end{matrix}\right\}} \quad \underset{\text{Oxide of Ethyle.}}{\left.\begin{matrix}(C_4H_5)'\\(C_4H_5)'\end{matrix}\right\}O_2} \qquad \underset{\text{Ethylene.}}{(C_4H_4)''} \quad \underset{\text{Oxide of Ethylene.}}{(C_4H_4)''O_2}$$

The action of oxydizing agents on this substance gives rise to many compounds comparable with inorganic bodies ; one series of ethylene derivatives may be placed side by side with the series derived from hydrochloric acid, namely :—

$$\begin{matrix}C_4H_4O_4 & ; & C_4H_4O_6 & ; & C_4H_4O_8\\HClO_4 & ; & HClO_6 & ; & HClO_8\end{matrix}$$

XUM

Oxide of ethylene is a gas at ordinary temperatures; but below three degrees centigrade it is a liquid. When a glass tube containing this body is opened, a jet of vapour rushes out, and may be lighted. If this vapour be conducted in a jar of hydrochloric acid gas, it immediately enters into union with it, with almost the energy and rapidity of ammonia. It is an unique base, without nitrogen, and without a metal; but it connects these two classes of bases together. It bears a remarkable analogy to an oxide of a metal, yielding definite compounds with acids, and even displacing some mineral bases from their combinations with acids. Its salts form double compounds with salts of barium, calcium, iron, zinc, copper, lead, and mercury, and these compounds invariably contain two equivalents of the metal. From various considerations, however, Professor Wurtz is led to conclude that the equivalents of these metals should be doubled; an argument in favour of this conclusion being drawn from their specific heat, which is half that of many of the other elements. If the equivalents were doubled, these metals would occupy a position in the salts above named identical with that occupied by ethylene. Oxide of ethylene is capable of combining directly with water, in the same manner as some metallic oxides; if the water be in excess, glycol is formed; if the oxide preponderate, other hydrates are produced, containing two, three, or four equivalents of the oxide to one of water. An analogy may be traced between these hydrates and certain complex hydrates of silicic and stannic acids, the relations of which had previously seemed somewhat doubtful.

But oxide of ethylene unites not only with hydrochloric and other acids, to form a great variety of saline compounds, but also with ammonia, forming bodies containing one, two, or three equivalents of oxide to one of ammonia. Of these there are several analogous to the ammonia compounds of copper, mercury, and platinum.

ROYAL GEOGRAPHICAL SOCIETY.—*June* 16.

Surveying Voyage in the Pacific.—Dr. Shaw read a paper on the Surveys of H.M.S. *Herald*, in the Pacific, under the command of Capt. H. Mangles Denham, R.N., F.R.G.S. This surveying voyage, undertaken in consequence of the representations made to Her Majesty's Government of the benefits which would result to commerce and navigation from a thorough examination of the dangers of the Western Pacific, extended from the year 1852 to 1861. A slight conception of the results of this voyage may be realized when it is mentioned that no fewer than 163 determinations of latitude and longitude were obtained, besides 2601 magnetic results, 41 islands carefully mapped, with 42 reefs and shoals, and 450 miles of the Australian coast-line. One of the many practical results is, that ships making the voyage from India and China to Australia can now save one-fifth of the distance usually traversed, owing to many supposed reefs having been expunged from our

chart, etc. In the South Atlantic, in lat. 37° S., lon. 37° W., soundings were obtained in 7706 fathoms; more than 16,000 feet deeper than the highest mountains are high.

Discoveries in Canaan.—Dr. Charles Beke then read the second paper, entitled "Notes on an Excursion to Harran in Padan Aram, and thence over Mount Gilead into the land of Canaan." The town of Harran, near Damascus, having been long since identified by Dr. Beke with the Harran or Charran of Scripture; this journey was undertaken by him, accompanied by Mrs. Beke, in December last, for the purpose of verifying this identification. Their road was from Beyrout to Damascus, and thence about fifteen miles further east to Harran of the Columns, so called from three Ionic columns, which, with numerous other architectural remains, attest its great antiquity. At the entrance to the town from the west is an ancient draw-well, which Dr. Beke regards as representing "Rebekah's well." On the first of January of the present year, the travellers proceeded to trace the "seven days' journey" of the patriarch Jacob in his flight from Padan Aran. They "passed over the river (Pharpar or Awaj), and set their faces towards the Mount Gilead;" which, unconnected with any other mountain system, serves as a landmark and guide to travellers crossing the plains of Hauran from the north or east. Their route lay along the great Haj road from Damascus to Mecca, passing through Eshmiskin, the residence of Ahmed-et-Turk, the Sheikh of the Sheikhs of Hauran, of whose noble and disinterested conduct in protecting the Christians of Edr'a during the massacres of 1860, Dr. Beke made honourable mention. Near Mispeh, at the summit of Gilead, was discovered a *cromlech*, resembling Kit's Cotty House in Kent. Passing Mahanaim, and following always in the footsteps of the patriarch, they reached the Jordan near the "ford Jabbok," where Jacob was met by his brother Esau. Here they were nearly drowned in crossing the river, after which they were attacked by Beduins; but in spite of those mishaps, they arrived in safety at Nablus, the Shechem of Scripture, on the tenth day after their departure from Harran.

Mr. Rutherford Alcock, F.R.G.S., H.B.M.'s Envoy Extraordinary etc., in Japan, then read a short paper giving an account of his journey, overland, from Nagasaki to Yeddo, in Japan, principally in order to see the newly-opened port of Osaca. He started from Nagasaki on the first of June last year, and in consequence of the many obstructions on the part of the natives, owing to their unconquerable hatred to foreigners of all nations, had the greatest difficulty in bringing his travels to a successful termination. The paper also gave an interesting description of the curious customs of the natives, character of the soil, and the state of our relations with the Japanese government. Mr. Alcock did not seem to consider it wise to force on the Japanese commercial relations for which they were not prepared, and the effect of which would probably be to disturb the existing state of society in Japan without substituting anything better.

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ROYAL INSTITUTION.

On Force.—Dr. Tyndall's Lecture on the Correlation of Mechanical Force and Heat, delivered before the members of the Royal Institution, offers so many remarkable facts, that we are desirous to reproduce them in a condensed form. A substance suspended at a height of sixteen feet above the earth's surface, and allowed to fall, reaches the surface in one second of time, its velocity, which has been regularly accelerated, being then at the rate of thirty-two feet per second. If the movement of this falling body is arrested, the force is not lost, but converted into heat. Thus the force of a body falling sixteen feet is sufficient, if suddenly arrested, to raise its temperature three-fifths of a degree Fahrenheit. The work done, or the mechanical force exerted by any moving object, augments with the square of the velocity; thus, doubling the weight of a cannon-ball doubles its power; but doubling its velocity, though the original weight is retained, quadruples its effect. Hence the efforts of artillerists to augment the velocity of their projectiles. A rifle bullet has at least forty times the velocity of a body falling for one second: hence, when suddenly arrested, as by an iron target, the heat generated, provided it could be concentrated in the bullet, would raise its temperature to about 960°, sufficient to melt the lead.

The conversion of muscular force into heat is strikingly shown in the concussion of flint and steel, as in the old method of obtaining a light. Energetic chemical union is always attended with the evolution of heat, which may be regarded as being produced by the falling together of atoms at a high velocity. The heat so evolved can be made to reproduce the exact amount of force that was arrested in its production. Thus, the union of a pound of coal with about two pounds of oxygen evolves an amount of heat capable, if properly applied, of raising a hundred pounds weight to a height of twenty miles. The coal raised every year in England amounts to 84,000,000 tons, which, were they all applied to the production of force, would be equal to 108,000,000 horses working constantly; or a pound of coal may be regarded as equal to the force of three hundred horses working for one minute.

The fact that force may be converted into heat has given rise to a theory which attributes the light and heat evolved from the sun to the falling of meteoric bodies on to its surface. Of the amount of heat produced by this luminary, some idea may be gained from the fact that the earth receives only 1-2,300,000,000th part. Moreover, it is calculated that the heat given out by the sun every minute is sufficient to boil 12,000,000 cubic miles of ice-cold water. This vast amount of heat is supposed by Dr. Mayer of Heilbron to be due to the falling into the sun of meteorites. The objection to the theory that these bodies are too few in number is met by the fact, that at one observatory alone as many as 240,000 have been observed in nine hours.

Meteoric bodies attracted by the sun would necessarily move with a high and rapidly-accelerating velocity, and it is calculated

that a body falling into the sun at a velocity of 390 miles a second, would attain a temperature 9000 times that produced by the combustion of coal. A body the size of the earth falling into the sun would supply its heat for about one hundred years, but would make no appreciable increase in its bulk; and were the earth's motion suddenly arrested, the heat developed would raise the temperature to such a degree that the elements would be dissipated in vapour. Notwithstanding the difficulties in the way of receiving this theory of Dr. Mayer's, it was regarded by Dr. Tyndall as that which offered the best explanation of the cause of solar heat.

NOTES AND MEMORANDA.

DIFFUSION OF RUBIDIUM.—M. Grandeau discovers this newly-recognized metal in coffee, tea, tobacco, grapes, and crude tartar. The tobacco employed came from Kentucky and Havannah. The leaves were acted upon by water, which was evaporated, and the residue calcined and tested by the method of spectrum analysis, which indicated potassium, a small quantity of lithium, and a notable proportion of rubidium. Coffee is still richer in rubidium than tobacco; but, as is the case with tea, yields no trace of lithium. He found no rubidium in colza, cocoa, and cane sugar, nor in certain kinds of fucus.

DISTRIBUTION OF SPRINGS.—The Abbé Richard, Professor at the little school of Montlieu, announces his discovery of what he calls a "hydrogeologic" law, by which he professes to be able to tell, after a brief examination of the soil, the position and depth, together with the volume of the water to be found below. He gives numerous instances of successful predictions, but states that before explaining his method he wishes to verify it by further experiments.

EXPERIMENTS ON SOLUBILITY.—M. Gay-Lussac has ascertained that the "solubility of a body is not modified when it passes from the solid to the liquid state." The converse of this proposition is also affirmed, that is to say, "that the presence of a solvent does not modify the fusing temperature of a body if no chemical action takes place." Thus, if finely-divided sulphur is suspended in sulphuric acid, bichloride of tin, and amylic alcohol, which are three of its solvents, it is seen to enter into fusion (be dissolved) in the three liquids exactly at the same temperature of 111°·5 Cent. Phosphorus enters into fusion at 44° Cent. in water, the various alcohols, chloroform, bichloride of tin, etc. Similar observations have been made with iodine, and various fatty bodies, always with similar results.

TRANSIT OF TITAN.—M. Chacornac has presented to the French Academy a drawing of the passage of Titan over the disk of Saturn. In addition to the shadow M. Chacornac perceived the satellite itself contrasting with the brilliant bands in the centre of the planet—near the margin the satellite became invisible. This phenomenon is the inverse of that which occurs when Jupiter's satellites make their transits, and indicates a difference in the atmosphere of the two planets. The observations were made with the great Foucault telescope.

THE GREAT SPIRAL NEBULA.—In our last number we mentioned the examination of this wonderful formation in *Canes Venatici*, by M. Chacornac, with the Foucault reflector. The following are the remarks of this astronomer in presenting his drawing to the French Academy:—"We must first notice the stellar appearance of the luminous centres of this double nebula, and observe that the central nebulosity of the greatest of them, has under high magnification the appearance of a whirlpool of little stars environing a principal star, which has not the planetary character indicated by Lord Rosse. These stars, of which those nearest the centre are seen through a nebulous veil, are not the only novelties, for as many as

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nine are found distributed in the whorls of the great nebula, and which are not shown in the drawings of Lord Rosse. In addition to these objects, of which I hope to discover more, I would call attention to divers branches of the spiraloid nebula as crossing each other in a different manner. The configuration of the most brilliant spirals, as indicated in our drawing, establishes the accuracy of the representation given by Sir J. Herschel. The branch which ties the smaller to the greater nebula, cuts the two principal spirals of the latter, near the place where these branches cross, in such a way that the interlacing of the curves presents the aspect of a spherical triangle. The companion nebula itself exhibits a spiral form, and not the appearance of a planetary disk, surrounded by an uniformly distributed atmosphere." In a communication with which we have been favoured by M. Chacornac, he informs us that he does not intend to compare the Foucault telescope in point of power with the giant at Parsonstown. This observation of the distinguished astronomer has reference to the remarks made in our last number.

Paraffin Oils.—At the request of the Manchester Sanitary Association, Mr. Charles O'Neil, F.C.S., has examined many specimens of paraffin oils. Out of twenty-five bought in Manchester, sixteen agreed with genuine samples of the Paraffin Company; the other nine differed from these, and from each other; three or four purported to be American, and were called petroline, kerosine, and photogene. He also obtained fourteen samples from the springs in Pennsylvania and Canada. One sample from London and one from Liverpool formed an explosive vapour with air at as low a temperature as 60° Fahr., and might be considered decidedly unsafe. At 85° there gave an explosive mixture with air. Of the remainder, only four formed an explosive mixture at 100°. Of the rest, three did the same at 120°, and the twenty that were left did so at 150°. Of the twenty that would not make an explosive mixture at 120°, two were American, and eighteen Young's, all of whose manufacture were found safe. Out of thirty-two samples, twenty were quite safe, three less so, and nine dangerous. In specific gravity, the American oils are generally below 816°, but two bad samples were as high as 865°. Thus specific gravity is no test of their safety. Nor is the boiling point, as many substances have so high a diffusive power as to compensate for high boiling points —coal naphtha, for example, which boils at 260°, gives an explosive mixture almost instantly even at the freezing-point.

Canine Madness.—M. Berthaud, writing in *La Patrie*, states that two mad dogs were recently taken to the Veterinary School of Alfort, and shut up in a cage. They exhibited all the symptoms of hydrophobia, and made desperate efforts to escape and attack the bystanders. After some days both had puppies, and in turns they manifested maternal affection, and gave way to paroxysms of their malady. At the expiration of a time not named they died, and the puppies which survived are kept to see whether they will become afflicted with the maternal complaint.

Bolides.—Professor Newton, U.S., describes two of these meteors, which he saw on the 2nd and 6th of August, 1860. The first, he says, was dissipated in our atmosphere, or in the earth, and he thinks its enormous velocity would account for its dissipation before it reached the ground. Those which let fall meteoric stars he thinks travel at a lower speed.

The Companion of Sirius.—M. Lassell, on hearing of Mr. Alvan Clark's discovery, directed his telescope (at Malta) to search for it, and found it with a power of 231. The angle of position was 83°·85, the distance from the great star 4″·92. Mr. Lassell is astonished at the discrepancy in the measurements of distance, which at Cambridge, U.S., appeared 10″·37 on the 20th of February; at Paris, 20th March, 7″·4; at Malta, 11th April, 4″·92.

Railways and Health.—Dr. Gallard communicated to the French Academy a paper on this subject, in which he shows from statistical evidence that the stokers and guards are not subject to any special maladies peculiar to their vocation, and that with reference to throat and pulmonary attacks during winter, much good is effected by their taking a cup of tea or coffee, or a basin of soup every two hours, or less. In many districts, where intermittent fevers had prevailed from time im-

memorial, he states that the drainage effected by railway works has removed these disorders.

An Oyster Shell Island.—M. Aucapitaine describes an island composed of layers of oyster shells in the Lake of Diana, on the east coast of Corsica, and which bears some resemblance to the shell mounds of Saint Michel-en-Lherm in La Vendée. The Corsican island, like these masses, is formed of the shells of species still living. It is between three and four hundred yards in circumference, and the greatest elevation about thirty yards, the mean elevation being rather more than two yards above the sea-level. The fishermen say the Romans used to deposit there the shells of the oysters, which they salted for exportation, but he does not believe the island had an artificial origin.

Logwood as a Disinfectant.—M. Desmartis describes to the French Academy an ointment made with equal parts of fat and extract of logwood, as removing the nauseous odour of putrefying sores.

The Guinea Worm.—Mr. H. J. Carter, F.R.S., finds some confirmation of his idea that the Guinea worm is a monster growth of a worm whose natural habitat is not of the human body, and whose young may be introduced through the sudorific ducts in the skin, from the behaviour of certain Filaridæ who make their way into the tissues of fungi. He tells us that free microscopic Filaridæ frequent gelatinous algæ and large fungi by myriads, and that when examining a large digitiform Xyloria which grows on the decayed trunks of tamarind trees, he saw delicate thread-like bodies which appeared to exhibit animal motion, and which projected from the conceptacles of the plant one from each. Extracting a few with a fine needle, and transferring them to a little water on a slide, he found them to be young Filaridæ. The mouths of the conceptacles did not exceed 1-1880th of an inch in diameter, which is less than the size of the openings of the human sudorific ducts. These observations were read at the Medical and Physical Society, Bombay, and published in the *Annals of Natural History*, No. liv.

Fungous Disease.—The same authority considers that the fungous disease which ravages the bones and soft part of the feet and ankles is occasioned by the entrance through the sudorific ducts of minute spores in an amœboid state, and which attain a monstrous growth as the black fungus in the human body.

Mesozoic Life in Australia.—The *Annals of Natural History*, No. liv., p. 486, publishes a letter from Professor Owen to Dr. Francis, stating that Mr. J. S. Poare dredged up a living encrinite from eight fathoms at King George's Sound, Western Australia. Professor Owen adds, "This, in connection with Stutchbury's discovery of a living *Trigonia* at Fort Jackson, and other evidences of mesozoic life at the antipodes, noticed in the published descriptions of the fossil marsupials of British oolites, is an interesting fact.

Phosphorescence of the Sea.—According to *Cosmos*, this phenomenon was exhibited with extraordinary splendour at Cherbourg on the 18th of May.

Carbonic Acid as an Anesthetic.—Dr. Ozonam detailed to the French Academy on the 2nd of June his experiments on this subject. After forty trials with delicate animals, whose sleep he had prolonged for one or two hours at a time without accident, he operated upon a human subject suffering from a deep abscess in the thigh. He began by administering a mixture of three parts of carbonic acid and one of common air contained in a caoutchouc bag, and furnished with a long tube, terminating in an enlarged opening, capable of receiving the mouth and nose. This was applied so loosely that the patient could respire air as well as the gas mixture. In two minutes he was asleep with accelerated respiration and abundant perspiration from the face. This last phenomenon, Dr. Ozanam observes, appears to be the result of a specific action of carbonic acid, which produces it, if directed upon the skin as a douche, or in a bath. The patient evinced no consciousness when the incision was made, but the inhalation of the gas was suspended just before the last cut, which was felt, and the young man awoke. When the gas is properly administered, consciousness is recovered as soon as the process is suspended, and Dr. Ozonam claims for his method greater safety than belongs to chloroform. M. Flourens spoke very favourably of the new plan. It is quite

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impossible to tell from Dr. Ozanam's description what proportion of carbonic acid his patient really did inhale. Professor Miller says, "if the proportion exceeds three or four per cent. of the air, it acts as a narcotic poison." We mention this as a warning to our non-medical readers against foolish experiments.

MOUNTAIN BAROMETER.—Under this title Messrs. Horne and Thornthwaite have produced a very excellent aneroid, especially adapted to facilitate the measurement of heights. Being only 2½ inches in diameter, it is very portable, while from the excellent workmanship, no practical loss of efficiency is the consequence of its reduced size. The face is graduated in two circles, the outer one giving the barometrical pressure in inches and tenths of an inch. Below this is the second circle upon which the peculiar convenience of the instrument depends. This is graduated in spaces corresponding with hundreds and thousands of feet, so that a mere inspection is sufficient, without any calculation, for the measurement of ordinary heights. Thus if the hand points to 1000, and on being carried to an elevation indicates 1100, it is evident that the last station is 100 feet higher than the first. Where the elevation to be measured is considerable, there will be a difference of temperature between the upper and lower levels, which must be allowed for to obtain a correct result; and the makers of this instrument supply a convenient and easily worked table, calculated in degrees of Fahrenheit according to the formula of La Place. To test the accuracy of the instrument, we have made repeated trials with heights of twenty or thirty feet and upwards, always obtaining closely approximate results. We have also compared its indications with a mercurial barometer, and observed its prompt indications of slight changes in the density of the air. We have likewise carried it loose in our pockets during long walks, and on two railway journeys, to see if a good shaking would do it any harm. The result of these experiments has been very satisfactory, and we can, therefore, recommend it to the tourist as a pleasant companion, serving the double purpose of a good barometer and measurer of heights.

NEW PLANET.—Mr. Tuttle, Cambridge, U. S., has discovered the 73rd planet. The asteroid resembles a 13 magnitude star, and was seen on the 8th of April, near β Virginis.

SOAP BUBBLES AND METEOROLOGY.—M. Felix Plateau having been requested by his father to throw away a liquid of a bad quality which had been employed to produce films, endeavoured to make it form a sheet of liquid in its descent, when to his surprise it took on the shape of a large bubble, and fell slowly. He repeated the experiment a good many times with soapsuds, and sometimes succeeded in making as many as fifteen bubbles at a time. He recommends a hemispherical vessel about five inches diameter, holding a considerable quantity of the fluid, which should be thrown at an angle of 45° with the horizon, and have a spinning motion communicated to it. In this experiment the elder Plateau saw an illustration of the formation of vesicles of vapour. The Abbé Moigno remarks in *Cosmos* that such a result was quite unexpected, and is eminently curious.